Beyond Functionalism: A Quantitative Survey and Semiotic Reading of Hadrian's Wall

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Beyond Functionalism

A Quantitative Survey and Semiotic Reading of Hadrian's Wall

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MMIX

Richard Hartis, PhD Thesis Abstract

Beyond Functionalism: A Quantitative Survey and Semiotic Reading of Hadrian's Wall

Hadrian's Wall is perhaps one of the best studied, but least understood, Roman monuments in Britain. Traditional interpretations have sought to identify one underlying principle to the Wall's function. Similarly, the Wall's purpose has often been interpreted as solely functional, with either military or 'customs barrier' arguments proposed. However, military theories are at odds with both general Roman practice of the time, which sought to defeat enemies in the field, and the Wall's generally low level of soldiery per kilometre. Customs barrier arguments cannot account for the seemingly illogical placement of structures along the line of the Wall. Furthermore, both these interpretations are connected to a broader dialogue between the Victorian era, which saw the rise of Wall-scholarship, and the modern world which effectively excluded the Roman context within which the Wall was constructed.

It is the question of the Wall's intent and purpose, as well as the structure's place in the wider Roman world, that this thesis explores. This necessitates an innovative combination of techniques including historiography, theory, quantitative survey and modelling. A theoretical standpoint is adopted that considers the construction from a symbolic perspective as an explicit means for understanding the original purpose of the Wall. Quantitative survey is used to reveal the full extent of the structure's symbolic power, the results of which can also evaluate dominant functional theories. Importantly, in emphasising theory and the Roman context alongside traditional functional models, this thesis reconnects the Wall to its original context within the Roman world. This research aims to stimulate debate on both the purpose of the Wall and its place in the wider Roman world, whilst also creating a framework for using quantitative theory to assess symbolic potential.

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Declaration

None of the material in this thesis has been previously submitted for a degree in this or any other university. This thesis is the result of my own work.

Statement of Copyright

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1 | Introduction

In purpose the Wall was undoubtedly military.

DANIELS, *FACT AND THEORY ON HADRIAN'S WALL*, 1979, 360.

§ 1.1 | Aims and Objectives

Hadrian's Wall is one of the best known Roman monuments in the world. As both a UNESCO World Heritage Site and major tourist attraction, the Wall is recognised as a structure of international importance. However, it is not solely relevant in the modern era, but is a major resource for understanding the Roman empire. As a monumental structure spanning the Tyne-Solway isthmus, it was an important project for the Roman state and represented a vast investment of labour, resources and time. The array of archaeological research conducted on the Wall emphasises its importance and this is most recently summarised in the Hadrian's Wall Research Framework[1] and David Breeze's 14th edition to the *Handbook to the Roman Wall*.[2] However, despite this high level of scrutiny, the Roman state's intention in building the Wall is one of its least understood aspects, with little new discussion of this subject in the most up-to-date works.[3]

It is this question of intent and purpose that this thesis explores. Previous interpretations of the structure's purpose have tended to

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[1] Symonds & Mason, 2009ab.

[2] Breeze, 2006b.

[3] Symonds & Mason, 2009b, 42 has a single paragraph on this subject, highlighting the need to draw on a far larger body of data and information. Breeze, 2006b, is primarily descriptive and was not intended to discuss function in depth.

emphasise functional explanations, often seeking a singular underlying rationale for the Wall's existence. Many of these ideas are conceptually rooted in the Victorian era and consequently exclude proper consideration for the original Roman context of Hadrian's Wall. This thesis will take a different approach and develop an innovative combination of historiography, theory, quantitative survey and modelling. This focus on the original intent and motivation for the initial construction of the Wall necessitates a chronological limit for this study examining the period of *c*.A.D. 122-130.[4] Symonds and Mason note that the function of the Wall is a controversial subject and that there is a lacuna in our understanding.[5] It is hoped that such a broad ranging thesis will promote discussion on this contentious issue.

The Wall itself is a linear barrier running from coast to coast across Northern England between the Tyne and the Solway. The nearby Roman installations on the Cumberland coast are often considered an extension of its structure. The placement of the monument, close to the line of the Stanegate road and amongst a large number of forts comprising the northern 'military zone', has led to the Wall being associated at various times with the so-called 'Outpost' and 'Hinterland' forts. The curtain wall is interspaced with turrets, milecastles and forts and is flanked by the ditch to the north and the Vallum to the south. The Cumberland coastal structures continue the milecastle/turret anatomy,[6] though only the Cardurnock peninsula possesses known linear barriers in the shape of ditches. The structure was built in the A.D. 120s with multiple alterations in plan under the auspices of the Roman military. These alterations can be seen in the turf wall in the west, the variable wall widths of

[4] Inevitably earlier and later developments will need to be discussed, however, this cut-off point is strictly enforced for the quantitative survey. The chronology is taken from Breeze & Dobson, 2000, 86-7, Table 7, and is reproduced in Tables 4.11 and 6.25 for convenience.

[5] Symonds & Mason, 2009b, 42.

[6] Though the nomenclature differs, with coastal milecastles being called 'milefortlets' and turrets becoming 'towers'.

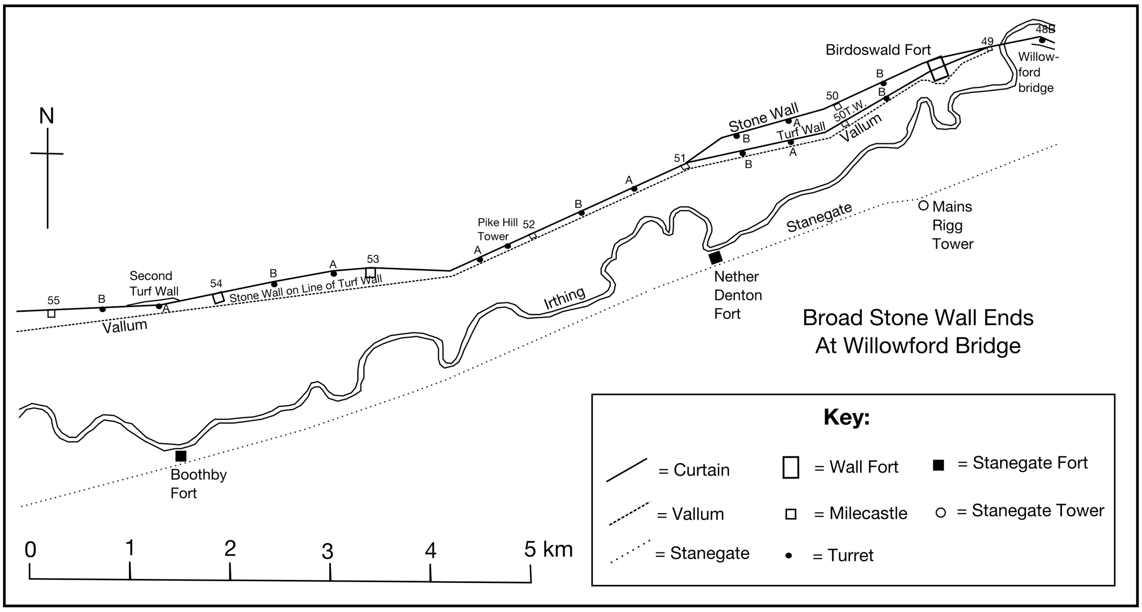

Fig. 1.1: Wall anatomy near the River Irthing.

the stone curtain and the addition of forts. A sample of the Wall's form is shown on Figure 1.1.

The systematic nature of the Wall's anatomy has helped create a recursive relationship, informing and being informed by, a functional approach from a military perspective. These interpretations are models that see the Wall's purpose as its smooth running and operational effectiveness, concentrating on the structures and eschewing archaeological theory and the experience of 'people'.[7] Such interpretations include overtly military models,[8] and the use of the Wall as a means for extracting taxation.[9] Functional models tend to be monocausal, eschewing plurality in their attempt to find the one significant factor that underpins the Wall's operation.[10] Such interpretations have resulted in the perception of Roman military studies in general, and Wall studies in particular, as 'narrow, unimaginative, unconcerned with theory and stagnant in methodology'.[11] From early study in the late-16th century,[12] right

[7] Allason-Jones, 1988; James, 2001 are examples of recent work 'repopulating' the Wall. Much of this work has concentrated on epigraphic, sculptural or funerary record. See §2.5 and Symonds & Mason, 2009a, Chp.8.

[8] For example, Luttwak, 1976 and Donaldson, 1988.

[9] E.g. Mann, 1974; Dobson, 1986, 7; Breeze & Dobson, 1986, 145; Kerr, 1989.

[10] Woolliscroft, 2001.

[11] James, 2002, 5.

[12] An anonymous Elizabethan author discusses the reconstruction of the Wall to defend against the Scots, Bain, 1894, 300-2. See §1.3, infra.

through to the modern day,[13] much of this work has been influenced by, as well as influencing, contemporary situations and views of empires and frontiers. This functional bias can be seen in the epigraph which opens this chapter. This thesis argues that this bias often says more of the contemporary world than that of the Romans.

The Wall's Roman context is all but absent from much analysis, and will be discussed later. Many interpretations of the Wall's intent and purpose are effectively dialogues between Victorian antiquarians and modern scholars.[14] Consequently, the aims of this research are twofold: to pursue a theoretical and symbolic approach in order to redress the functional bias present in much of the Wall's interpretation; and to stimulate new discussion on the intended role of Hadrian's Wall to re-situate the Wall in its Roman context. To achieve these aims this thesis will pursue the following five key objectives:

- identify, expose and explain the root of the functional bias in consensus interpretations;
- emphasise landscape theory, *praxis* and symbolism as an explicit means of understanding the original purpose of the Wall;
- perform a quantitative survey of the structure and its supply, both food and materials, to reveal the full extent of the symbolic power of the structure;
- use the quantitative results to evaluate consensus models;
- reconnect the Wall to its Roman context by linking effort and labour requirement to the structure's symbolic power. This in turn associates the Wall with imperial power and the broader Roman world.

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[13] Daniels, 1979 is highly functional and militarily orientated in his interpretation. Breeze, 2006a; *id*., 2008, draws parallels between the Antonine Wall and Checkpoint Charlie. Mann, 1974, is explicit in discussion of customs control. See §2.4.

[14] Rivet,1976 discusses Rudyard Kipling's Wall in relation to later interpretations.

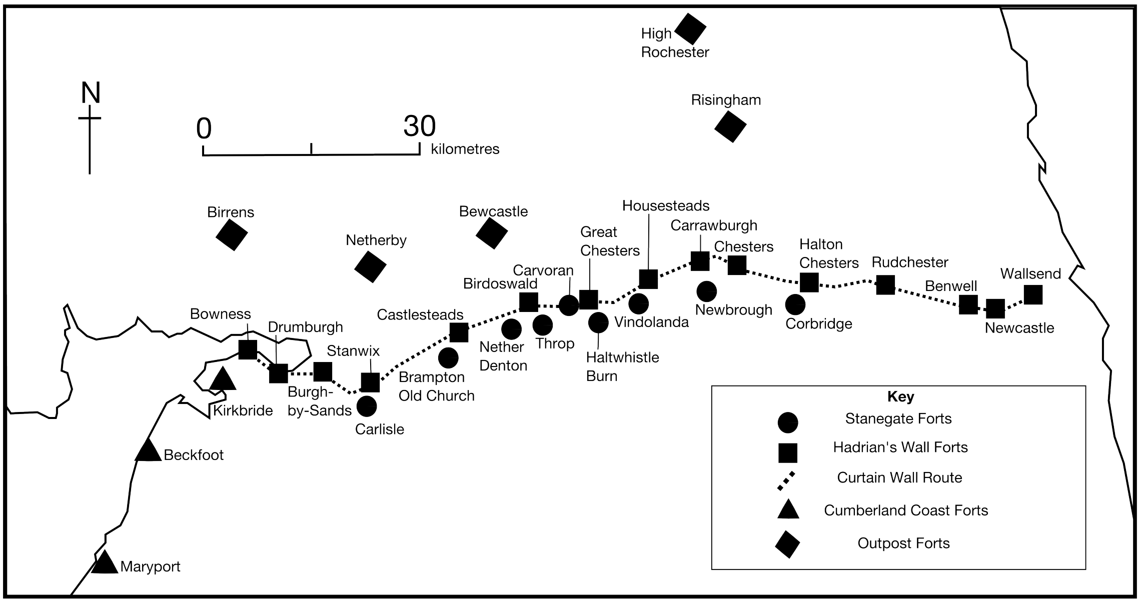

Fig. 1.2: Sites and structures studied.

These aims and objectives are applied to a study area comprising a broad corridor of Roman military activity around the Tyne-Solway isthmus. The Stanegate is included as its existence is often connected to the reasons for, and the purpose of, Hadrian's Wall.[15] Similarly, the structures of the Cumberland coast are studied as recent work has sought to demonstrate an association between the Wall and this series of installations.[16] Finally, the Outpost forts are included due to their regular connexions to the Wall as its 'eyes and ears'.[17] The study area is shown on Figure 1.2.

The Hinterland forts were a group loosely defined as the forts south of the Wall as far as York, and north of the Wall up to the Forth-Clyde isthmus, and were formerly considered part of the Wall network.[18] However, there is little indication that they were a specific group closely linked to Hadrian's Wall. As this thesis deals specifically with the construction and original intended purpose of

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[15] See Hodgson, 2000 for the most recent argument of this case.

[16] Potter, 1979, 359; Woolliscroft, 2001, 88-102.

[17] Daniels, 1990a, *passim*; Wolliscroft, 2001, 79-88.

[18] To the south this included the forts of Dere Street and Country Durham; Lanchester, Binchester and Piercebridge for example; as well as the Stainmore Gap and the likes of Hardknott and Ravenglass. Northwards, forts at Broomholm, Burnswark and Ladyward were considered to be part of this group. Graham, 1979, has a section dealing specifically with the County Durham forts,but excludes those in Cumbria and north of the Wall. Also see Frere, 2001; Breeze, 2006b, 102.

the Wall, a chronological limit relating to the completion of the structure in *c*.A.D.130 is imposed. Whilst the forts at Hardknott and Ravenglass are Hadrianic foundations,[19] albeit geographically distinct from the Wall, the other forts are often earlier or later.[20] This is reflected in much of Wall literature, with few mentions of the Hinterland forts in modern accounts of the Wall.[21] Consequently, the Hinterland forts are not included in this study.[22] Furthermore, the Wall's bridges are excluded due to either a lack of information from which to construct a model, as is the case with *pons Aelius*, or due to their construction outside the chronological limits of this study, such as at Chesters and Corbridge.[23]

To achieve these aims, Chapter 2 discusses the bias in the interpretation of the sources used to support functional theories. Here a historiographical study of select Classical and post-Classical literature most commonly used to support functional theories is presented.[24] The chapter considers the author's own alternative translations and provides a more nuanced understanding of the literature's goals and context. Continuing this theme, the secondary objective is an exploration of how these works have been applied, from the antiquarian era through to modern-day scholarship.[25] A sample of work which exemplifies this use of Classical-era works is examined, revealing the ways in which the modern world is reflected in their interpretations of Roman structures.

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[19] Breeze, 2006b, 102.

[20] The Dere street forts occur earlier than the Wall. Milton fortlet, for example, is a later Antonine structure. Frere, 2001, 289.

[21] Breeze, 2006b, 102, deals with the hinterland forts in a mere paragraph.

[22] Understanding the effect the forts that are introduced to the Iron Age landscape had will be important for the impact of Hadrian's Wall. This is an area of potentially important future study, see §9.5.

[23] Bidwell & Holbrook, 1989; Symonds & Mason, 2009a, 53-4.

[24] The anonymously authored *Scriptores Historiae Augustae*, Gildas and Bede. See §1.3.1 and §2.2.

[25] The importance of Antiquarian scholarship on Wall studies can be seen in J. Collingwood Bruce's *Handbook to the Roman Wall*. This is now in its 14th edition, published in 2006, with the first edition released as the Wallet-book in 1863.

Chapter 3 provides a theoretical context for the Wall's construction in order to overcome the theoretical stagnation often associated with research on Hadrian's Wall. This will examine the broader context and multi-faceted nature of Roman symbolic behaviour,[26] as well as the symbolism associated with construction,[27] before applying these approaches to the study area. Importantly, the idea of 'imperial immanence' is explored,[28] and the reification of different concepts along the line of the Wall is considered. Furthermore, the purpose of monumental structures in the Roman world is also assessed and applied to the Wall.[29] These aspects are all discussed within the framework of a 'subjective' landscape,[30] where theories such as *praxis*[31] and taskscapes[32] are highly relevant due to the interactive nature of the Wall's landscape.

Intrinsic to the power of the act of building is understanding its magnitude. The primary way of assessing the impact of the structure is through quantitative survey. Chapter 4 thus details the methodology required for this process. Due to the Wall's nature as a complex form built from multiple materials, no single work study is utilised. Instead a varied array of sources and experimental approaches are required in order to assess the cost, labour demand and materials for the Wall's construction. The use of multiple sources will also show how this study connects with broader quantitative theory, setting the methodology in its expanded context. Whilst the quantitative approach is normally given over to functional considerations, the importance of effort and scale as a key part of a

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[26] Mattern, 1999, 22: 'It is especially here, in the realm of the moral and the psychological, that we find complexity in Roman policy and thought'.

[27] Thomas, 2007, 28: 'The epic tone of the emperor's speech [recorded at Lambaesis] elevated their banausic labours in constructing a fort to a heroic military achievement.'

[28] Boyle, 2003, 30.

[29] Thomas, 2007, Chp.3.

[30] Bender, 1993. The terms 'lived' or 'experienced' landscapes are also applicable. 'Subjective' is preferred here as it is in line with Bourdieu's attempts at reconciling the subjective and objective stand points seen in the use of *Habitus* and *Field*, the former is discussed in depth throughout Chp.3.

[31] Bourdieu, 1990.

[32] Ingold, 2000.

structure's symbolic power renders this method central in understanding the Roman context.

Chapter 5 and Appendix 1 begin the process of examining the structures that form the Wall complex. This starts with the Stanegate, the road parallel to the site of the Wall running from Corbridge to Carlisle. The Stanegate is often connected functionally to Hadrian's Wall either directly, by being incorporated into the Wall system,[33] or by providing frontier dispositions that were eventually superseded by Hadrian's Wall.[34] Thus the Stanegate is seen either as a proto-frontier, or as a frontier in its own right that eventually failed. Hadrian's Wall is thus seen as the logical successor to the Stanegate, and its form is supported by similar developments in other areas of the empire. However, this presupposes a homogenous idea of frontiers that change little in purpose across space and time.[35] Consequently, reassessment of the Stanegate's interpretation as a 'frontier' is of great importance as this is deeply entwined with the form and function attributed to Hadrian's Wall. Military models presume that the Wall, if it was the Stanegate's successor, would have the same function and purpose as the much earlier structure.[36] Thus, a reassessment will include model testing of the existing understandings for the Stanegate, and the introduction of quantitative survey as a key tool for investigating similarities and differences between structures.

The various structures which comprise Hadrian's Wall are considered in depth in Chapter 6 and Appendix 2. The functional bias in much Wall scholarship is examined and the quantitative survey is used to test many of the assertions made about the Wall. This includes new measurements for the number of people required to construct the Wall and the time scale of construction,[37] building

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[33] Seen in Woolliscroft, 2001, Chp. 2.
[34] See Hodgson, 2000.
[35] Mattern, 1999, 111.
[36] Hodgson, 2000.
[37] Appendix 5 shows the data for season by season breakdown of labour.

significantly on other studies. The quantitative data is expanded into the symbolic realm. Understanding the symbolic whole of the Wall is a key part of this chapter, examples of the concepts reified and how they relate to each aspect of Hadrian's Wall, will provide context and evidence for the structure's symbolic power. Furthermore, the link between symbolic strength and effort expended on construction will be demonstrated empirically through the quantitative survey.

Continuing this process, Chapter 7 and Appendix 3 concentrate upon the Cumberland Coast. The Cumberland coast is often seen as a mere extension of Hadrian's Wall in terms of anatomy and function.[38] The quantitative data tests this assertion, demonstrating the direct application of this methodology for comparing different aspects of structures. The effect this connexion has on the symbolic message of the Wall is a key facet of this chapter. In a similar vein, the Outpost forts are assessed in Chapter 8 and Appendix 4 through the same method. The Outpost forts are a fundamental part of the Wall's interpretation as a divisive barrier, acting as its 'eyes and ears', thus the functional link between Wall and Outposts is of key importance.[39] Again, discussion of perceived connexions to Hadrian's Wall is the main objective of this chapter. Their symbolic value is also explored, drawing parallels from the wider Roman world in terms of the impact forts had upon the landscape.[40]

Before concluding in Chapter 10, the penultimate chapter performs a survey on the supply demands of the soldiers who constructed the Wall complex.[41] This examines the possibility of supply as a drain on available labour, and the potential symbolic benefit of different types of supply. Intrinsic to this chapter is the idea of supply as yet another strand through which the Romans could control the

[38] Potter, 1979, 359; Woolliscroft, 2001, 88-102.

[39] Daniels, 1990a, *passim*; Woolliscroft, 2001, 79-88.

[40] See Witcher, 1998 for the symbolic impact of roads.

[41] Quantitative data for the environmental model can be found in Appendix 6. The supply demands of the post-completion garrison can be found in Appendix 7.

landscape. Importantly, this chapter uses the data from the quantitative survey as the basis for a new estimate on the labour needed to build the Wall. In turn the environmental model presents new data based around these results and applies this to the wider symbolic impact on the landscape around Hadrian's Wall.

By investigating the purpose of the monument the study is chronologically limited to the completed form of the Wall, in *c*.A.D. 130.[42]

§ 1.2 | Method and Context

A quantitative survey, which forms the core of this thesis, involves estimating the volumes and costs of materials and labour for each structure. Normally this process would involve either detailed plans or complete structures. However, this is not an option for Wall studies, therefore excavation reports are used to provide the basic dimensions of the structures. Unknown variables, such as height,[43] are estimated in order to give a rough idea of a structure's final form. The labour required to build the estimated structure can then be calculated. This relies on the processes involved and the speed at which construction can take place.[44] The final step is the use of the labour study and the materials survey to calculate total cost. This involves the total volumes of materials and the number of person days required to construct the structure. Ancillary factors, including equipment and scaffolding cost are also factored in giving a final monetary value for the structures forming the Wall. This cost can be seen as an expression of surplus labour, demonstrating the scale of the available labour and resources.[45]

The quantification of supply relies on having figures for the number of people to be supplied whilst building the Wall. These are

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[42] Current accepted chronology from Breeze & Dobson, 2000, 86-7, Table 7, repeated in Tables 4.11 and 6.25 for convenience.

[43] For more on the assumptions required see §4.4-6.

[44] See §4.8.

[45] Costs are discussed in §4.12.

provided by the quantitative survey's work study, thus this thesis will be using these new figures to estimate supply.[46] The process involves an estimation of types and rates of consumption for both personnel and animals,[47] consequently, animal numbers need to be determined.[48] The effect of this demand on the landscape is calculated through estimates of the land's carrying capacity[49] which leads to estimates of the total area affected.[50] Finally, the labour needed to work this amount of land for the food supply can be calculated and added to the total construction labour to give a new estimate for the Wall's population.[51]

Attempts to perform a quantitative survey on Hadrian's Wall are not new. The oldest recorded example is from the Elizabethan-era, published much later by Joseph Bain in 1894's *The Border Papers*. This contained an anonymously authored letter to Queen Elizabeth I (1533-1603) advocating the rebuilding of Hadrian's Wall as defence against the Scots.[52] This letter conjectured that the 'Pightes Wall' would have cost the Romans some £19,000, and that recreating the Wall would cost the Queen no more than £30,000.[53] The uncertain conflation of both the Wall and the Vallum, resulting in a claim of a wall 'at the leaste 16 foote in thicknes'[54] demonstrates that knowledge of the Wall's anatomy was not entirely understood, thus these estimates are unreliable.

J. Collingwood Bruce and Sir Robert Rawlinson estimated the cost of the Wall at mid-19th century prices. They claimed that the Vallum would cost £23,271, the ditch £34,906 and the Wall £1,021,269; the total labour demand of the Wall is estimated at 2,865,671 person

[46] See §6.8.1 and §9.3.2.
[47] See §9.3.3.
[48] See §9.3.2.
[49] See §9.3.4.
[50] See §9.3.5.
[51] See §9.3.6.
[52] Bain, 1894, 300-2; Birley, 1961, 23-4.
[53] Bain, 1894, 302.
[54] Bain, 1894, 301.

days.[55] Here, Bruce and Rawlinson estimate that 'the largest number of men that we can conceive to be brought to bear at once upon the Wall, including such Roman troops as could be spared from military operations, is ten thousand'.[56] This work force, it was claimed, could complete the Wall and Vallum in 286 days.[57]

Far more recently, Hunter Davies' 1974 publication, *A Walk Along the Wall*, discussed a quantitative survey based around a modern reinterpretation of the Wall. This used materials, such as reinforced concrete, and methods similar to motorway construction to construct a Wall of identical dimensions to the Roman original. Here two projections are made at prices correct for 1974: the first, a cantilevered wall with a projecting platform, cost £55 million; the second, purportedly built 'completely to the Roman plan' with the Wall constructed in reinforced concrete, costing £80 million.[58]

Both Davies' work and Bain's correspondent, despite their claims to deal with the Wall, are firmly rooted in their contemporary contexts. Just as Bain's anonymous author focusses on the Wall as a defensive structure,[59] so too does Davies presume that the cost of the Wall can be calculated by replacing ancient materials with their modern equivalents. The result is a quantitative survey of a wall that is not 'Roman'. This is one of the key ways in which this thesis and previous work differs, this study aims to understand the construction and meaning of the Wall in its Roman context. It does not apply the contemporary world to the structure in the manner seen in these sources, as a defence against the Scots or as an exercise in modern architectural techniques. Similarly, whilst Bruce and Rawlinson assess the Wall in materials and techniques that were available to

[55] Bruce, 1851, 94-5, Interestingly, the Vallum is cheaper, in this appraisal, than the ditch despite its greater complexity.

[56] Bruce, 1851, 95.

[57] Bruce, 1851, 95.

[58] Davies, 1974 286-7.

[59] Hingley, pers. comm., has highlighted how the author is referring to the 'civilising' of the border region and not solely its defence. This poses questions about the manipulation of older sources similar to the themes explored in Chapter 2.

the Romans, much has changed in our knowledge of Wall anatomy since the mid-19th century and the timeliness of this study is further emphasised with the recent work of the Hadrian's Wall Research Framework.[60]

Regarding supply, Roger Kendal attempted in 1996 to quantify the transport and material demands of Hadrian's Wall, including the requirements of carts and other load-bearing devices, numbers of livestock required as well as numbers of men needed to run and organise the movement of raw materials to the work site.[61] However, since he lacked figures for the number of soldiers involved in construction, Kendal did not make an attempt at quantifying the food demands and considering its supply, though some quantification of the demands of the animals is attempted.[62] This thesis will build and expand upon Kendal's work by including the food demands, derived from new figures developed in the quantitative survey, which allow an informed estimation of the number of soldiers involved in construction and supply. This highlights the benefits of a quantitative survey as a central tenet of this study.

Peter Hill's 2004 publication *The Construction of Hadrian's Wall* provides the most recent study of Hadrian's Wall. Importantly the goals of Hill's study and this thesis are quite different: Hill considers the 'practical aspects of the physical construction of the Wall';[63] whereas theory and broader questions are considered here. Similarly, Hill limits his study to the supply of the work site in terms of materials. This thesis offers a more holistic perspective in its inclusion of the food supply. Most importantly, Hill's study is confined to examining the stone-built section of the Wall east of the river Irthing. Consequently the turf and timber area of construction

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[60] For example Huntley *et al*., 2007; Symonds & Mason, 2009. Functions of the Wall are highlighted by Symonds & Mason as a key area lacking in knowledge, *id*., 2009b 42. This study directly connects to this, and other, lacunae.

[61] Kendal, 1996.

[62] Kendal, 1996, 149-50.

[63] Hill, 2004, 1.

found west of the Irthing is not considered, the ancillary structures found on the Cumberland coast and the Outpost forts are also not examined in any great detail. Similarly, the Stanegate is not discussed as Hill's goals do not include the development of the structure's function, or an assessment of how the Wall has been studied. Finally, there are noted methodological differences due to the different aims. Hill does not include simulations or reconstructions for the structures as these are not a key component of his study. However, they are fundamental to this thesis as transparency is needed when quantifying structures whose final forms remain unknown.

The core of the quantitative process here is the measurement of conjecture. This is based upon the establishment of the likely three dimensional shape of the structure, usually referred to as a 'reconstruction'. However, as noted by Brian Hobley,[64] such terms create an impression of finality that is simply not possible. Thus, as with Hobley, the term 'simulation' is preferred here as it reflects the fact that new evidence, and alternative methodologies, can be used to alter the outcome. This flexibility is an intrinsic part of this study and can be seen in the multiple projections for different possible simulations.[65] Furthermore, it must be noted that the simulations are not the primary aim of the work, they are vital steps towards understanding and modelling the survey as means rather than ends.[66]

The simulations themselves, due to their reliance on the measurement of conjecture, are inherently open to assumptions as

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[64] Hobley, 1982, 223.

[65] This flexibility is further reflected in the spreadsheets for the quantitative survey, see Appendix 1, where locked variables are used as reference points, thus any changes to these automatically cascade through the survey. In this way the survey can respond to new information or changes in stand point quickly and easily. This can be seen in §9.3.6 in Tables 9.30-1, where the 200 day building season is paralleled with the 250 day agricultural work season, almost instantaneously giving an alternate projection.

[66] As with Shirley, 2000, 2, the diagrams used in this work are not for the sake of providing definite answers on the form of the Wall's structures, they are for clarity.

these are necessary for quantifying incomplete ancient structures. For example, aspects as simple as the heights of structures are much debated. Thus it is necessary to consider and assess multiple options for building shape and size. These are, of course, subject to the norms of what would be reasonably available to the Roman army in the area whilst taking into account long-distance supply. This demonstrates a strong case for simulation, rather than reconstruction, as it accounts for the unknown variables where suppositions are required. The evolving debate can be factored into these simulations. Importantly, where there are multiple possibilities without a clear indication of which would have been used, the option with the lowest requirements will be selected. This can be seen in the different building types for turf and timber ramparts, with two options for the top width, one of 3m, the other of 1.8m.[67] According to this methodology the smaller figure is chosen. This minimising approach provides consistency in calculation allowing volumes, costs and labour to be inflated if needed. However, there is the unavoidable consequence that some assumptions of low values have the effect of providing maximum impact. For example, in most cases, minimising the scale of a structure lowers the labour demands and costs. For some calculations, assumptions of minimal variables may lead to higher rates: e.g. low soil fertility results in a greater land usage, as more is needed to enable the same food supply.

The study of the construction of all aspects of the Wall undertaken here differs from previous attempts at quantification. As a consequence, it connects with the far broader literature on quantitative surveys. The work of John Chapman, Robert Shiel and Šime Batović in prehistoric Dalmatia[68] provides invaluable quantitative calculations as well as work calculations for stone built structures. Such an approach is expanded significantly, and brought

[67] See §4.6.1.

[68] Chapman *et* al*.,* 1996.

into a Roman context, by Elizabeth Shirley's Inchtuthil study[69] which looks specifically at this Roman legionary fortress in Scotland. The current thesis takes these methodologies and applies them to the Wall, and auxiliary forts in particular. At Inchtuthil, Shirley benefited from one clearly defined period of occupation and could survey every aspect of the fort. This clarity of evidence is absent from the Wall and renders an identical study impossible. Importantly, Shirley's quantitative survey shows the labour requirement per structure of the fort, and broken down as percentages of the whole. Thus the partially preserved Wall forts can have their surviving anatomy calculated as part of the whole of the fort. This figure can then be scaled up to estimate the total labour demand of the full fort.

Janet DeLaine's study of Caracalla's Baths in Rome uses a similar quantitative approach and also aims to look at social implications.[70] The goals included the quantification of the labour cost, and the organisation of large-scale building projects. Also, a comparison of the cost of the bath complex in relation to other imperial spending is sought.[71] These ideas are developed for Hadrian's Wall here by connecting the effort required to build monumental structures to their symbolic power. Similarly, this thesis studies the Wall in light of its semiotic intent and impact on its surroundings. This is an important advance on DeLaine's study as it places these factors at the centre of the research.

Similarly, Neil Faulkner's work on late-Roman towns in Britain utilises the quantitative method to assess the amount of building taking place in the 4th and 5th centuries A.D.[72] Whilst these results are interpreted as evidence of decline,[73] it is the method, rather than the conclusion, that is important here. Here projections of buildings are

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[69] Shirley, 2000.
[70] DeLaine, 1997.
[71] DeLaine, 1997, 12.
[72] Faulkner, 1998; *id.*, 2000.
[73] Evident in the title of the published work, *The Decline and Fall of Roman Britain*, and in the title of the work's seventh chapter, 'The fall of Roman Britain'.

measured in order to estimate the total output of new structures in Romano-British towns.[74] However, the connexion between labour demand and symbolism is not made. Faulkner's goals are aimed solely at assessing how much building work occurs within the province, not examining wider symbolic behaviour or non-functional reasons for construction. There is, therefore, a significant difference between this thesis and Faulkner's study in the usage of quantitative data, this study mobilises such data for consideration in the symbolic realm.

Christopher Martins has used quantitative survey in order to model consumption and consumer behaviour at Roman villas.[75] The figures generated from such a survey can be used to remove false perceptions of structures based on value judgements.[76] Similar false perceptions can be seen on Hadrian's Wall, value judgements such as 'high' and 'low' quality stonework are often used. These are often the opinion of the excavator and lack qualification in data.[77] Quantitative survey provides this qualification, however, this strength is balanced by the fact that pure fiscal values cannot reflect altering social values over time and context. The use of costs derived from the modern world means that they are loaded by their nature.[78] This criticism can be ameliorated with a full contextual analysis, though the wealth of Roman writing and structures allows this only for Roman perceptions. Martins' publication does not include the methodology employed to gain the exact costings of the villas.[79] This thesis includes these figures in order to provide clarity in the many assumptions required for applying the quantitative process to ancient structures.

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[74] Shown in Faulkner, 2000, 31, Fig.11.

[75] Martins, 2005, Chp.3 specifically deals with the application of consumer theory.

[76] Martins, 2005, 19.

[77] Hill, 2004, 2-3, cites a number of false perceptions. For example, Bruce's Second Handbook, 1884, 32, and continuing to the 13th edition, described facing stones as 'carefully squared freestone blocks' when the facing is in fact roughly squared rubble. Hill notes that the difference in finish and labour between these two was massive, and the misuse of the term presents a false image.

[78] Martins, 2005, 20.

[79] Martins, 2005, 20.

Fig. 1.3: Rampart and gate reconstruction, Lunt Roman fort, Baginton.

Importantly, both Faulkner and DeLaine provide information only for stone and brick structures. This thesis goes beyond solely assessing the stone sections of Hadrian's Wall, thus other literature and evidence is required to provide a methodological context. However, due to the restrictions inherent in the building materials, there are far fewer studies, reconstructions or simulations available for turf and timber structures. Brian Hobley's work at the Lunt, near Coventry, shown on Figure 1.3, provides detailed information about the quantities and types of materials involved, as well as the skill and effort required to complete the rampart, gateway and granary.[80] It must be stressed that this is not to say that Hobley's reconstructions are the epitome of Roman military turf structures, as noted above, Hobley himself warns against such a view in his use of the term 'simulation'.[81] Rather, the structures give form to conjecture, and demonstrate what is and what is not practical when building with turf and timber.

The structure of the Wall is but one aspect to estimating its impact. Previous attempts at quantifying supply for the Wall have been limited to materials; food provision was not a consideration.[82] Since the quantitative survey produces new evidence for the size of the

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[80] Hobley, 1967, 1971, 1974, 1975, 1982.

[81] Hobley, 1982, 223.

[82] Kendall, 1996; Hill, 2004.

work force, it is now possible to think about food demands alongside the building materials. Military food supply itself has been the focus of considerable recent research. However, it is normally considered through the lens of campaigning armies: John Peddie considered the supply requirements of the Roman invasion of Britain;[83] Donald Engels examined the supply of Alexander the Great's eastern campaigns;[84] Phillip Roth looked at the broad spectrum supply requirements of people in the ancient world, and the Jewish War specifically;[85] finally Paul Erdkamp considered the broader questions of the Roman army and the economy,[86] as well as specific supply during the wars of the Roman Republic.[87] Such a broad corpus of literature, when combined with environmental modelling of the type discussed by W.H. Manning,[88] can provide insight into what was both possible and reasonable for supply in the study area. These aspects, combined with new labour demands, result in a more holistic understanding of the food needs of those who built the Wall and the effect these had upon the landscape.

§ 1.3 | Sources

The simulations are based on the dimensions of the structures as revealed through archaeological excavation. Excavation reports consequently form the primary data resource for the quantitative survey, the data extracted and the sources used are listed in the relevant appendices. Preservation varies greatly across the study area, with the central sector surviving better than its turf-built western counterpart, or the sections beneath the cities of Carlisle and Newcastle upon Tyne. However, the published excavation

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[83] Peddie, 1987.
[84] Engels, 1978.
[85] Roth, 1991; *id.,* 1999.
[86] Erdkamp, 2002
[87] Erdkamp, 1998.
[88] Low yields are used as a 'worst case scenario' for assessing what level of self-supply would be possible. This is assumed as the actual pollen evidence is too poor to make any widespread assumptions about the carrying capacity of the Wall's land. Barber *et al*., 1994. As noted, this low figure will result in an increase of the area affected.

reports of even the well preserved sections of the Wall are not without their problems. Their aim was often not to provide a detailed investigation of the structure, but rather to confirm the line of the Wall, identify the existence of interval structures and to explore their regularity. Similarly, the location, recording and assessment of small finds like pottery and brooches were often the focus of excavations.[89] The reports from the late-19th and early-20th centuries are particularly notable for their concentration on these subjects.[90] For example, Nether Denton's first excavation report contains little detail on the dimensions of the site, or the walls discovered therein, information which is required for quantitative survey:[91]

> In digging the foundation of the new Parsonage, Mr. Shipman said they discovered nothing more than portions of walls formed of cobble stones laid in clay, and from the arrangement of these walls, he surmised that had been the foundations of a wall of superior masonry, or the inner works of the encampment. At the west and north of the house they found other walls, which also had evidently formed part of the camp.

This is the total discussion of the structure in the report, which makes no mention of dimensions, and provides no description of a general plan and location. The rest of the report is concerned with coinage and pottery, which often formed an important topic of concern in the 19th and 20th centuries. The use of these reports in constructing simulations is a purpose for which they were not designed. This must be factored into any understanding of the veracity of the simulations quite literally built upon them. To combat this, in all cases, the most complete excavations and fullest

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[89] For small finds see Charlesworth, 1961; Snape, 1993. For pottery see Birley & Gillam, 1948; Swinbank, 1955; Gillam, 1970.
[90] Though Hill, 2004, 2 excepts F.G. Simpson and J.P. Gibson's work as 'one of the few early qualitative assessments which bears some relations to the extant remains.'
[91] Shipman, 1866-1873, 88. Hill, 2004, 1-2 also considers this issue.

information on the form of the structure has been sought and a list is given in each data appendix showing which reports were used in constructing the simulations.

Conservation and consolidation of the Wall poses a further problem in that modern remeasuring may effectively be quantifying a late Roman, antiquarian and/or modern reconstruction. The multiple phases of rebuilding that occurred under the Romans[92] are compounded by consolidation of the Wall by John Clayton and later F.G. Simpson. Here Roman material was left *in situ*, with drystone blocks used to build up the Wall's face before being sealed with a turf cap.[93] Subsequent authorities, including the Ministry of Works, the Department of the Environment and English Heritage have all been involved in the uncovering and consolidation of the Wall. This was, until the late 1970s and early 1980s, completed without the oversight of professional archaeologists.[94] Thus Hill stated: 'the original stones provide a record of their working of them, but position and alignment do not.'[95] Sadly, the recording of where this consolidation has taken place has, in many cases, been lost. Jacquetta Hawkes, in an article in *The Observer,* claimed 'repairs and alterations were destroyed without record',[96] thus the true extent of consolidation is hidden. Hill, consequently, declares:[97]

> Much of the Wall now visible is thus not Hadrian's Wall but Clayton's wall, or DOE wall. However carefully a wall or structure is rebuilt, something is lost and it is to an extent archaeologically 'dead'.

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[92] Hodgson, 2008 places these phases of reconstruction into the context of the now defunct concept of 'Wall periods'. Bidwell, 1999, 95-7 discusses the Roman alterations made to Wall Mile 1 at Buddle Street.

[93] Woodside & Crow, 1999, 95.

[94] Crow, 1991, 52.

[95] Hill, 2004, 4.

[96] Woodside & Crow, 1999, 95.

[97] Hill, 2004, 4.

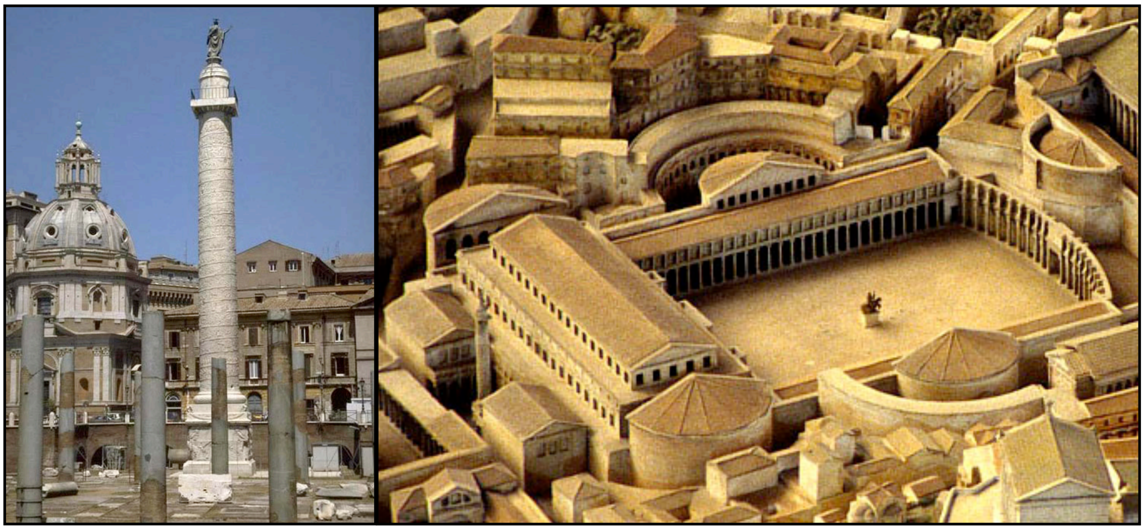

Fig. 1.4: Trajan's Column, left; Forum Traiana, right.

Fortunately, for this study, despite the widespread nature of Wall consolidation, the central aspect of its dimensions have not been substantially altered. Whilst position and alignment of the stones within the Wall and interval structures are no guarantee of their archaeological veracity, these aspects are not being used to inform the simulations of the Wall. The repair of wall 'bulging', where pressure from the wall core forces the facing stone outwards, is another aspect which is mentioned.[98] Fortunately, such repairs bring the Wall closer to its original form and thus the goal of this thesis. Nevertheless, there is little that can be done to combat the effects of consolidation, other than remembering that this contributes to the simulations' margins of error. Fortunately, the flexibility of the simulations can go some way to ameliorating this issue. Hence this discussion is not stating that older excavations were 'poor', or that consolidation was completely 'erroneous', rather it is drawing attention to the potential for errors in the simulations through the unconscious bias and limitations in knowledge which are bound to be part of any analysis or report, this one included, and their use for a purpose beyond their original remit.

Throughout this study, structures from around the Roman world are used as comparanda. Trajan's Column, shown on Figure 1.4, is a

[98] Hill, 2004, 4.

significant resource. Rather than taking an art history approach,[99] or using the column to inform the functioning of the Roman army and the history of the Dacian Wars,[100] it is the propaganda element of the structure that is relevant. Similarly, it is not just structures in the heart of the Eternal City which are used for comparanda, provincial structures such as Adamklissi, in Romania, and La Turbie, in France, are also considered from the perspective of propaganda.[101] This demonstrates how propagandistic monuments condition space in all areas of the empire, a factor which will be seen to be vital to Hadrian's Wall.

A central tenet of this thesis is that structures are not the sole form of evidence for the Wall. The Roman-era Wall can be illuminated with reference to various Classical and post-Classical sources. The anonymously authored, late-Classical, *Scriptores Historiae Augustae*; Gildas' 6th century *De Excidio Britanniae* and Bede's Mediaeval *Ecclesiasticum Historiam Gentis Anglorum* all make direct reference to the Wall. It should be noted, however, that their words cannot be taken verbatim as all three sources have their own agendas and biases that affect their reading of the Wall. Their lack of contemporaneity with the structure also affects their understanding. Gildas is an excellent example of this, as he is writing polemic his primary goal is not an historically accurate version of events.[102] Similarly, the *Scriptores Historiae Augustae*, and more specifically the *Vita Hadriani*, has been described as 'a

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99 For example, Gaur, 1977, cited by Hassell in the preface to Richmond, 1982. Some elements of the art history approach remain in modern works, see Coulston, 2003, 409-12.

100 Rossi, 1971 is the most prominent example of this, specifically pp.14-9 and Chp. 8.

101 Covered most recently by Thomas, 2007.

102 Higham, 1994, 13.

serious distortion of the facts'.[103] Consequently, the literature must be treated with the same critical approach adopted for the archaeological evidence.

Broader context is provided by a number of supplementary works not directly related to the Wall. Vegetius' *Epitoma Rei Militaris*, a late Roman treatise[104] compiled from earlier sources dealing with 'Military Things',[105] and Vitruvius' *De Architectura*, which was written *c*.130 years before the construction of the Wall, are both important. Similarly, a range of ancillary sources including pseudo-Hyginus' 3rd century *De Munitionibus Castrorum*, Appian's *Roman History* and Tacitus' *De vita et moribus Iulii Agricolae* are used where appropriate. Latin works have been read both in translation and in their original form, where the author disagrees with a translation a note and an alternative will be provided.[106] Consequently, this thesis includes discussion on a broad range of literature as well as the archaeology. Since both have different traditions in study, this integrated approach is rarely used for examining the Wall. This thesis explicitly connects both text and archaeology for the Wall, as well as considering the effects of the misuse of text in interpreting the Wall's remains.

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103 Birley, 1976, 12-3, 16-7, discusses how the work is later than the events, and later still than claimed. Also mentioned is the use of bogus sources throughout and the occurrence of false characters, documents and names. Nevertheless, there is still the possibility that earlier sources, closer to the time of the Wall, were used in its compilation. Birley, 1997a, 3-4, cites Marius Maximus' continuation of Suetonius' *Twelve Caesars* as a possible source in both the *Vita Hadriani* and Cassius Dio's history. Despite this, it is clear that the original sources of the *Vita Hadriani* have become too occluded in the text, and, as such, this work should be handled cautiously.

104 Dated between the death of Gratian in 383 and 450 through 'the correction of a copy at Constantinople in 450 by one Fl. Eutropius, whose note to that effect survives in one family of manuscripts.' Reeve, 2004, v, viii-x.

105 Those earlier sources which survive in fragments in the text are Cato, Celsus, Frontinus and Paternus. Milner, 1996, xiii. The English translation of 'Military Things', whilst less readable than the traditional title of 'Epitome of Military Science' is more faithful to the intent of the title. *Rei*, coming from the root of *res*, quite literally means 'thing'; the use of 'science' in its traditionally translated title owes more to the rise of this subject in the Renaissance world and is thus not a reflexion of the original text. See James, 2002, 9-10, for discussion of the effects of the systematic study of the Roman military and the rise of military science.

106 The latest translations of works have been sought, for example Milner, 1996. If no specific translation exists then the Loeb Classical Library was used as standard. The author has a background in Classical literature.

§ 1.4 | Theoretical Context

The last twenty years has seen heavy critique of traditional models of Roman frontiers.[107] The established opinion of Roman frontiers and their associated installations is epitomised in the quotation which opens this chapter,[108] in the recent past they were seen militarily and functionally as the first line of defence for Roman territory. There are a number of assumptions intrinsic in such a model: that people and states were connected to the landscape and borders in a similar way to today;[109] that frontier works and features represented the limit of Roman power;[110] that defence of such territory would take place along linear barriers[111] and that the military function of structures was their raison d'être.[112]

However, Benjamin Isaac's paper 'The meaning of the terms *limes* and *limitanei*'[113] demonstrates that such a linear conception of frontiers, whilst matching the modern observer's understanding, does not reflect the norm in the Roman-era. Similarly, Charles Whittaker's *Frontiers of the Roman Empire: A Social and Economic Study* problematised the prevailing view of frontiers and frontier works, preferring to see such areas as a rich zone of socio-economic activity, where the admixture of Roman and 'other' created a fertile area of social formation.[114]

Traditional views of 'frontiers' do not take into account the landscape beyond topographical features. One of the primary weaknesses of many approaches to Hadrian's Wall is that they are monocausal in nature with a single distinct function presented as the goal of the Wall complex. This can be seen in David Woolliscroft's

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[107] For example, Whittaker, 1994.
[108] Daniels, 1979, 360.
[109] Whittaker, 1994, 3-8.
[110] Fletcher & Kipling, 1911, 22; Pelham, 1911, 164.
[111] Pelham, 1911, 170.
[112] Daniels, 1979, 360; Luttwak, 1976, 4; Donaldson, 1988.
[113] Isaac, 1988.
[114] Whittaker, 1994; also see Whittaker, 2004 for subsequent frontier theory work.

approach, citing signalling as the underlying principle;[115] and in David Breeze and Brian Dobson's 'customs barrier' argument.[116] Both proposals seek to connect the Wall to one overarching function. That landscapes and monuments can be multidimensional is not in doubt, looking for 'one landscape/one message'[117] is problematic. Whilst there may be a key reason behind the Wall's construction, it may not be directly functional, and the Wall may not have been viewed in the same way by all. An alternative perspective provided by this thesis is to explore the idea that landscape and the structures form a 'canvas of conflict', with different groups seeking to assert themselves, reading and interpreting in divergent and discrepant ways, using both landscape and the buildings as a medium and accepting that there would have been unintended consequences to Roman control and actions in the landscape.[118]

Such multiple interpretations mean that landscapes and structures can be both inclusive and divisive.[119] Attempts to dominate may well be understood clearly when they use familiar motifs.[120] Thus exploitation of recognisable materials and symbols provides potential legitimation to the dominant culture,[121] in this case the Roman state. Such attempts at legitimacy are again subject to divergent reactions: some may choose to accept, some to actively resist,[122] whilst others may participate though not accept.[123] Indeed, the intended message and conflict may also simply be lost, should a

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115 Woolliscroft, 2001.

116 Birley, 1956, 25-33; Dobson, 1986, 6-7, 25; Breeze, 2008, 13.

117 Bender, 1993, 5.

118 Bender, 1993, 3; Mattingly, 1997, 16; Witcher, 1998, 68; Mattingly, 2006, 520-2, 526.

119 Bender, 1993, 12, uses the example of Protestant parades in Nortern Ireland. On the one hand it is an event by which one group in part defines itself and lays claim to the landscape. On the other, it is divisive and highly charged for those not part of the group.

120 'Compatibility' in aspects like monumentalism, as well as the very materials structures are rendered in, may well provide comprehension of the symbolic message.

121 Duncan & Duncan, 1988, 125; Witcher, 1998, 64. For dominant cultures, and other forms, see Cosgrove, 1989, 128-34.

122 In the Wall's case, this could include attempted circumvention of the line.

123 Witcher, 1998, 64, gives examples for road use.

viewer have a fundamentally different way of reading the world around from those involved in constructing the landscape.[124]

Intrinsic in this process is that the landscape and structures are used: they are not a static, neutral, backdrop to human activity. Pierre Bourdieu's *Logic of Practice*[125] includes the theory of *praxis* which examines the ways in which day-to-day actions can affect perceptions.[126] Importantly, Bourdieu also considered in his theory of *habitus* the result of landscape formation, how it conditions those within and how they interpret the world. At their core, Bourdieu's theories are concerned with reconciling subjective and objective views and understanding how these standpoints are influenced and used to interpret the world around. This has specific resonance with landscape study, as traditionally objective views of space are contrasted with culturally-specific subjective views. It is the former that has dominated Wall studies, and the application of the latter which is studied in this thesis. Symbolism and control are key facets in affecting *praxis* and thus the *habitus* of the landscape: this makes Bourdieu's work highly relevant for considering Hadrian's Wall symbolically.

That symbolism can be as important as function is a key point. Consider, as an example, the role of money in the ancient world and its conversion to *maiestas*: money taken by the Roman state represents their power over others.[127] The functional part of this, the taxation, is not the goal, rather it is the means by which it undergoes a 'magical' conversion[128] and is transformed into *maiestas*. This is subsequently used to instil respect and terror in allies and

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[124] Duncan & Duncan, 1988, 122, illustrates this point with Aboriginal landscapes in Australia: 'A rock is a rock but also a mythic being'. The connexion between rock and mythological symbol may not be made by a non-Aboriginal observer.

[125] Bourdieu, 1990.

[126] Bourdieu, 1990, Chp. 3. Ingold, 2000, also discusses acts of 'doing' within the landscape, coining the phrase 'taskscape'. This is also highly relevant to the Wall.

[127] Mattern, 1999, 22.

[128] Bourdieu, 1990, 119-20.

enemies.[129] Given that one of the potential roles of Hadrian's Wall was a 'customs barrier',[130] this example is both relevant and important as it shows how Hadrian's Wall could have been a site, not of taxation, but of symbolic power that mediated status. Interestingly, due to this Roman view of economic exchange, this act mediated Rome's position for those complying, intending to gain respect from allies. However, the mediation also worked on those resisting, with the intention of inspiring terror from their enemies. Thus, the Wall is able to resonate with diverse groups of people, with differing definitions of their status between themselves and Rome. This single example demonstrates how functional readings are not entirely representative of the Roman era as they can fail to take into account non-quantifiable factors. These can be just as powerful in experiencing a structure as the traditionally explored facets of functionalism.[131] Importantly, it shows that the 'customs' toll is not the end point, but merely a step in the overall process of Roman symbolic and social behaviour.

§ 1.5 | Terminology, Abbreviations and Measurements

All measurements in this thesis are given in the most appropriate metric units. Figures are rounded to two decimal places when displayed in tables, though during calculation no rounding takes place in order to minimise mathematical distortion.[132] Throughout this work a number of abbreviations are used for both structural aspects and the publications commonly cited. Structural abbreviations are shown on the Table 1.1:

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[129] Mattern, 1999, 149. Loosely, *maiestas* can be defined as the majesty of the state, as well as the person, it is associated with conspicuous display and thus architecture. See §3.4.

[130] Birley, 1956, 25-33; Dobson, 1986, 6-7, 25; Breeze, 2008, 13.

[131] Such non-quantifiable factors are referred to by Carl *et al*., 2000 as 'non-real'. The former term is preferred here as it 'non-real' implies that such factors would be not as important in influencing the world as 'real' counterparts. Non-quantifiable, however, simply accepts that these are difficult facets to find, rather than implying a value judgement of relative importance. It should be noted that this is not a facet of Carl *et al.*'s work, but rather an implication of the choice of language.

[132] See §4.3.

Table 1.1	
Abbreviation	Meaning
T	Turret
MC	Milecastle
MF	Milefortlet
CT	Cumberland Coast Tower
TW	Turf Wall
SW	Stone Wall
CC	Cumberland Coast

Table. 1.1: Common structural abbreviations used.

All forts are referenced by their modern names, e.g. Housesteads rather than Vercovicium, due to the changing application of names throughout the 19th and 20th centuries.[133] The exception is Vindolanda as the tablets have revealed, beyond doubt, the name of the fort; furthermore, convention within even the most modern publications uses the Roman name rather than Chesterholm. The conventional numbering system devised by R.G. Collingwood for towers and milecastles[134] is used throughout for convention and clarity.

Abbreviations of commonly cited publications are summarised in Table 1.2:

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133 See Rivet & Smith, 1979; Frere, 2001, *passim*, for more on place names.
134 Collingwood, 1930a; *id*., 1930b.

Table 1.2	
Abbreviation	Full Title
AA1-5	*Archaeologia Aeliana*, series 1 to 5
CW1-3	*Transactions of the Cumberland and Westmorland Archaeological and Antiquarian Society*, series 1 to 3.
RHW	Birley, E., *Research on Hadrian's Wall*, Kendal, 1961.
WMW	Simpson, F.G. (Simpson, G., ed.), *Watermills and Military Works on Hadrian's Wall*, Kendal, 1976.

Table. 1.2: Common publication abbreviations used.

§ 1.6 | Summary

In examining the Wall in terms of symbolism and quantitative theory a number of important factors are covered in this thesis. Firstly, the examination of the literature and visual material not only seeks to situate the Wall back in its original context, but also connects the material culture with the texts that have discussed the Wall. For example, Gildas' interpretation of Hadrian's Wall can be linked to the structure's anatomy.[135] The quantitative survey gives the scale of the effort in both constructional and supply terms and is more ambitious than similar attempts for the Wall and in other areas of the Roman world. Importantly, by deconstructing the functional interpretations, and exploring symbolism as an equally important aspect, a deeper understanding of why and how the structure was built can be approached. The removal of the functional bias, combined with the quantitative results, demonstrate that the Wall took much labour, effort and cost to construct and that this was a key part of its symbolic strength. In turn this is used to mediate status right across the Tyne-Solway isthmus as Rome's primary way of making people and places 'become Roman'. This active interpretation of the Wall, focussed less uniquely on defence and more on cultural interaction, results in an understanding of the structure as playing a key role in the ongoing dialogue of Roman imperialism.

[135] Bruce, 1851, contains many reflexions on Gildas' claims about the Wall.

II | The Historiography of the Wall

[Hadrian] made for Britain, where he set right many things and - the first to do so - drew a wall along a length of eighty miles to separate barbarians and Romans.

SCRIPTORES HISTORIAE AUGUSTAE, 11.2

§ 2.1 | Introduction

This chapter aims to examine the way in which ancient literature has been used to support a sample of modern functional and military interpretations for the Wall. The ancient sources include the anonymously authored *Scriptores Historiae Augustae*,[1] Gildas' *De Excidio Britanniae* and Bede's *Historiam Ecclesiasticum Gentis Anglorum*. These three sources contain direct references to Hadrian's Wall, and are important works for examining the dominant bias in Wall studies from the Victorian era through to the modern day. Much modern Wall scholarship is formed in dialogue with antiquarian and Victorian sources, rendering an appraisal of these works highly relevant. Key works from the Victorian era include Bruce's *Handbook to the Roman Wall*,[2] Lord Pelham's *Essays*[3] and Rudyard Kipling's contributions to school history and children's books.[4] Edward Luttwak's *Grand Strategy of the Roman Empire*[5] and G.H. Donaldson's analysis of Hadrian's Wall[6] are exemplars of modern functional and military interpretations. David Breeze and Brian Dobson's backlash against militarily dominant theories, often

[1] Specifically the *Vita Hadriani*.
[2] Bruce, 1851.
[3] Pelham, 1911.
[4] Fletcher & Kipling, 1911; Kipling, 1906.
[5] Luttwak, 1976.
[6] Donaldson, 1988.

cited as the 'customs barrier' argument, are also examined.[7] Importantly, this chapter is not meant to be enyclopaedic for all scholarship concerning the Wall. Rather, it is intended to provide samples of the literature that best exemplify the dominant arguments.

The selected ancient sources are assessed both internally, through close examination of the language and norms of the time in which they were written, and in relation to one another. This is especially important for Bede and Gildas, as the former relies heavily on the latter and the subtle differences in interpretation are key to understanding how each of the authors saw the Wall. Furthermore, the context within which ancient and modern analysis takes place is vital. Assessment of the Victorian and modern works explores why certain aspects of the *SHA*, Gildas and Bede are given primacy. Much consideration is given to forms of retrojection, the placement of values from a different time onto ancient structures, and how it has affected many interpretations. In this way the roots of the functional and military bias in Wall scholarship is highlighted.

§ 2.2.1 | The *Scriptores Historiae Augustae*

The *SHA* contains only a single sentence associated with Hadrian's Wall, used to open this chapter. However, the brevity of this reference is inversely proportional to the importance and use of this text. The debatable authorship of the work, however, casts doubt upon the relevance of this famous line for the Wall's construction. Whilst earlier sources may well have been used in the compilation of the *SHA*, Marius Maximus for example,[8] the work is littered with bogus sources and false characters, documents and names. Undoubtedly the *SHA* is later than the events, including the construction of the Wall, and may be later still than claimed.[9] This garbled historical narrative is therefore likely to be accompanied by

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[7] Breeze & Dobson, 1978. See Daniels', 1979 review.

[8] Birley, 1997a, 3-4.

[9] Birley, 1976, 12-3. The *Vita Hadriani* is described as a 'serious distortion of facts'.

retrojection, with the values of the late-3rd/early-4th century applied to the early-2nd century Wall.

Consequently, the *SHA*'s statement about the Wall's purpose may not reflect the time of its construction. It is true to say that linear barriers did not develop in a vacuum, thus the late-3rd/early-4th century notions must have had some conceptual antecedents. However, it would be a less than nuanced understanding to repeat this transposition of later norms to the Wall itself.[10] It is important to remember that the divisive nature of Hadrian's Wall, as understood in the *SHA*, may not have been the case at the time of the Wall's construction.

The text of the *SHA* can act as guide to its context, other linear structures are mentioned and cited as divisive barriers. The German frontier appears a mere passage later and is identified as causing separation, *separuit*, by divisive barriers, *limitibus dividuntur*.[11] Hadrian's Wall is directly aligned with being divisive: 'to separate barbarians and Romans.'[12] The context of the *Vita Hadriani* is clear: dividing barriers are considered ideal. However, this is contra the role Roman military structures played in the 2nd century in stimulating trade and providing new markets.[13] This function is likely to have been ineffective if the Wall was totally divisive, a retrojected purpose may not be commensurate with the function of the Wall at the time of its construction.

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[10] Contra Dobson, 1986, 5.

[11] It is interesting to note, again on the subject of building materials, that the wooden nature of the German frontier is not the cause for scorn in the *SHA* that the turf construction of the Antonine Wall is to Gildas. This highlights the separation in time of the two works, and neatly shows how impressions can change. If this is the case with these two sources, 150 years apart, this serves to underline that statements about Hadrian's Wall in these texts should be treated carefully, as they are both further removed from the Wall temporally than they are from one another.

[12] 11.2: 'qui barbaros Romanosque dividerat.'

[13] Acknowledged by Dobson, 1986, 21. Kerr, 1989, shows that the economic role of the military was deeply ingrained. Similarly, incentives for locals to relocate to *vici* confirm that the Romans themselves saw a fiscal and civil dimension in their military. Jones & Walker, 1983, 190; Higham, 1989, 155.

§ 2.2.2 | Gildas

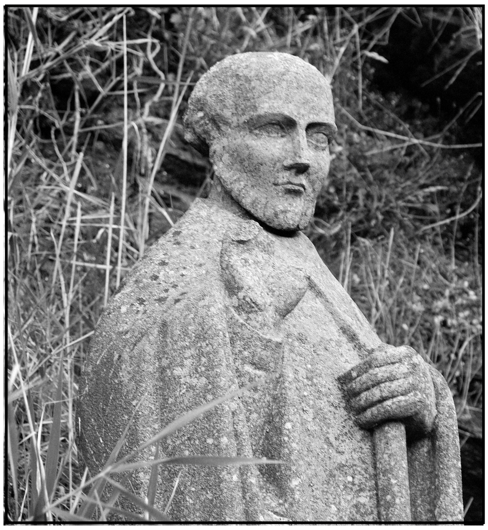

Fig. 2.1: Statue of St Gildas, near the village of Saint-Gildas-de-Rhuys, France.

Functional readings of the Wall have their roots in the three aforementioned works of classical and post-classical literature through their emphasis on certain parts of the texts. What these texts say, however, can be quite different from the arguments they are used to support. Indeed, even their validity for use on a 2nd century structure can be brought into question. Gildas was a 6th century writer, whose most famous work was *De Excidio Britanniae*, the decline of Britain. The title demonstrates the polemical nature of Gildas' work, within which he provides a narrative of Roman Britain through to its current state. He deals with both Hadrian's Wall and the Antonine Wall in two sections, 15.3 and 18.2. The former section refers to the Antonine Wall:[14]

> The British were told [by the Romans] to construct across the island a wall linking the two seas; properly manned, this would scare away the enemy and act as protection for the people. But it was the work of a leaderless and irrational mob, and made of turf rather than stone: so it did no good.

The latter, 18.2, is attributed to Hadrian's Wall for reasons which will become apparent:[15]

> [The Romans] built a wall quite different from the first. This one ran from sea to sea, linking towns that happen to have

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[14] DEB 15.3: Quos jussit inter duo maria constituere trans insulam murum, ut esset arcendis hostibus turba instructus terrori, civibusque tutamini; qui vulgo irrationabili absque rectore, factus non tam lapidibus quam cespitibus, non profuit.

[15] DEB 18.2: […] quia et hoc putabunt aliquid derelinquendo populo commodi accrescere, murum, non ut alterum, sumtu publico privatoque, adjunctis secum miserabilibus indigenis, solito structurae more, tramite a mari usque ad mare inter urbes, quae ibidem forte ob metum hostium collocatae fuerant, directo librant; fortia formidoloso populo monita tradunt exemplaria instituendorum armorim relinquunt.

> been sited there out of fear of the enemy. They employed the normal method of construction, drew on private and public funds, and made the wretched inhabitants help them in the work. They gave the frightened people stirring advice, and left them manuals on weapon training.

Taken at face value, Gildas claimed that the two walls of Roman Britain were built with the singular purpose of defence. Attention must be drawn to the context of the work. Gildas was not writing history, but rather polemic. Many of the points raised are for the purposes of driving home his argument; any analysis of Gildas must be tempered with this knowledge.[16] Importantly, Gildas is firmly entrenched in the ideas and the norms of his time, the 6th century, and not the early 2nd century of the Wall's construction. The Wall itself may well have become to considered defensive by the 6th century, but it may not have been constructed with this intent.

Gildas deals with Britain's two walls in a novel manner. Rather than simply retrojecting the ideas of his own time onto the Walls, he moves the structures forward through time, imbuing them with the properties of a later era.[17] What are these values, and how does the text reflect this? There is a clear presumption that such works as the British walls were defensive, the first of Gildas' walls, the Antonine, has symbolic power designed: '[to] scare away the enemy',[18] however, this was clearly not effective for very long as the frontiers are subsequently broken.

Gildas' choice of language intimates a nuanced understanding. The phrase used in *DEB* 15.3 is *instructus terrori*, *instructus* means 'to build, to construct'.[19] In which case the Antonine Wall, in this account, was 'built for terror'. However, *instructus* is derived from

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[16] Higham, 1994, 13.

[17] This demonstrates that knowledge of the two walls' archaeology and history was poor, and that such chronological liberties could be taken, deliberately or otherwise.

[18] Supra, *DEB* 15.3.

[19] *O.L.D.* def. 1. *Terrori* is far more common in post-Classical Latin, showing Gildas temporal distance from the two walls.

the stem *instruō and* can also mean 'to equip with knowledge';[20] similarly, another layer of meaning is added given the specificity of teaching to speaking. Gildas' choice of words shows that he considered the Antonine Wall to be quite literally 'teaching and speaking terror' to the enemy. Gildas demonstrates a knowledge of the rhetorical power of structures that is often ignored by those using this source. Gildas also implies a more definitive line-in-the-sand, using *terminos* rather than *limes*.[21] This choice of language also invoked the sanctity of barriers.[22] Concepts of the Walls as boundary markers are reflected in the language, and the structures themselves are made to fit this idea through the description and historical account. Importantly, the symbolic power of a structure that could 'teach and speak terror', and the religious associations of the word *terminos*, are ignored in functional interpretations which emphasise the physically divisive aspects.[23]

The ineffectiveness and weaknesses of Gildas' Antonine Wall highlight what is considered preferable. The later structure is Hadrian's Wall,[24] and is interpreted as more defensive in purpose

[20] *O.L.D.* def. 8.

[21] Whittaker, 1994, 8; Isaac, 1988, 130. The former sees such areas as a zone; the latter etymologically shows that the term *limes* had nothing to do with fortifications.

[22] As will be discussed at length in Chp. 3, *Terminos* has a religious association with the stone boundaries.

[23] Whilst Bruce is aware that Gildas' interpretation of the two walls was deeply influenced by his own period, 1851, 30, he often cites the defensive properties of the Wall. Newcastle: 'the necessity of defending the bridge, and commanding the Tyne would not be forgotten', *id*., 125; Housesteads: 'it is naturally defended on all sides', *id*., 215; Milking Gap: 'On all sides, except the western, it is naturally defended', *id*., 235; Bloody Gap: 'the Vallum is seen bending up towards the Wall, apparently to assist in defending the pass', *id*., 245; Caw Gap: 'The extreme jealousy with which the Romans defended and exposed situation is well shewn here', *id*., 246. This is just as small sample. The divisive influence of Gildas is shown in Bruce's analysis of the Wall in his reflexions on the *DEB*: 'An acquaintance with Roman discipline, a knowledge of the Roman art of war, ought to have given them great advantages over their less civilized neighbours on the north of the Wall, and enabled them easily to have retained that great structure as a boundary fence', *id*., 31.

[24] Hadrian's Wall was not always known as such. From Mediaeval times through to the 19th Century is was often referred to as the Pict's Wall; the Roman Wall was also a popular term in the 18th Century. Hingley, 2008.

than the rhetorical impact of the Antonine Wall.[25] Firstly, it is paralleled with the 'Saxon Shore' forts in the following section which are understood by Gildas to be expressly defensive:[26]

> [The Romans] also placed towers overlooking the sea at intervals on the south coast, where they kept their ships: for they were afraid of the wild barbarian beasts attacking on that front too. Then they said goodbye, meaning never to return.

The key point with this excerpt is the 'too', which directly relates to the preceding section and identifies Hadrian's Wall as defensive by association.

Furthermore, Gildas states that Hadrian's Wall is 'correctly' constructed from stone rather than turf.[27] The implication is that stone is more effective for defence, and defence is the purpose of the Wall. This is underlined by Gildas' portrayal of a wall defended by soldiers placed along its line: '[attackers] tore our wretched countrymen from the wall and dashed them to the ground.'[28] Gildas is using the context of his day, and moving the Walls temporally to this later period, in order to support his rhetorical point of decline.[29] Consequently, it would be unwise to take Gildas' account of the Wall at face value.

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[25] Interestingly, the attribution of the Antonine Wall as the earlier wall also hints at the defensive nature of Hadrian's Wall in Gildas' eyes. Hadrian's Wall seems to operate as a 'fall-back' position, when the Britons could not hold the more advanced line *in Barbarico*. The rhetorical point would not have been subtly underlined had Gildas appropriated the Walls in their correct order, this would have involved a push further into *barbaricum* which was not the act of the defeated people he portrayed.

[26] *DEB* 18.3: In litore quoque oceani ad meridianam plagram, quo naves eorum habebantur, quia et inde barbaricae ferae bestiae timebantur, turres per intervalla ad prospectum maris collocant, et valedicunt tamquam ultra non reversuri.

[27] […] quia et hoc putabant aliquid derelinquendo populo commodi accrescere […], compare 15.3 to 18.2. *Commodi* meaning in this instance 'proper', 'fit' or 'appropriate'. On a historical note, this also hints at the high status associated with 'textbook' signs of the classical world in this period; this is unsurprising given the Latin nature of the work itself.

[28] *DEB* 19.2: Interea non cessant uncinata nudorum tela, quibus miserrimi cives de muris tracti solo allidebantur.

[29] Higham, 1994, 9, 23-4.

§ 2.2.3 | The Venerable Bede

Fig. 2.2: 'The Venerable Bede Translates John' by J.D. Penrose, 1902.

Bede was an 8th Century monk based at the twin monastic sites Monkwearmouth and Jarrow. His most famous work is the *Historiam Ecclesiasticum Gentis Anglorum*, though he also wrote Chronicles and various Lives.[30] When dealing with the Wall, the *EH* was heavily influenced by Gildas' account of Roman Britain. He included the exact series of events that led to the construction of, in his view, first the 'Antonine Wall' and then 'Hadrian's Wall'. Bede, however, does alter Gildas' account with his separation of the vallum and the Wall itself, with the former attributed to Severus.[31]

There is a clear melange of influences in Bede's work, which can be seen upon close analysis. Importantly, some statements appear to be internally contradictory. The Wall as a divisive barrier is still a theme, which is hardly surprising given Bede's sources. Implicit in the concept of a barrier are people on the other side beyond the control of the Romans. This stands contra the *imperium sine fine* principle that one would associate with the high empire, the time of the Wall's construction. This highlights the context of Bede's sources rather than the context of the Wall.

Bede's account is far less binary than those of Gildas and the *SHA*. *EH* I.5 contains the first discussion of Severus' wall: here the excerpt, *receptam partem insulae a ceteris*,[32] is key. Rather than

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[30] Including the *Chronica Maiora*, the Life of St Cuthbert and a list of saints, the *Martyrology*.

[31] *EH* I.5. This serves to show how impressive a structure the vallum must have been, even in Bede's time.

[32] Translated in McClure & Collins, 1994, as: '[…] he [Severus] decided to separate the part of the island over which he had regained control, from the other unconquered tribes […].' A literal, less readable but more faithful, translation would not translate the word *receptam* as 'separate', but rather as 'take in': '[…] he [Severus] decided to take in the part of the island [that was] away from the untamed people […].'

using *serparuit*, *dividuntur* or *terminos*, as in Gildas and the *SHA*, *receptam* is preferred, meaning 'to take in'.[33] This is the first indication that Bede, when not directly using Gildas, has a different understanding of frontiers.

EH I.11 demonstrates this still further. Occupation to the south of the Wall is stressed with power, *dominandi*, over the area beyond the Wall emphasised:[34]

> [The Romans] had occupied the whole land south of the rampart already mentioned, set up across the island by Severus, an occupation to which the cities, lighthouses, bridges, and roads which they built there testify to this day. Moreover they possessed the suzerainty over the further parts of Britain as well as over the islands which are beyond it.

This is clearly not the divisive 'line in the sand' that Gildas and the *SHA* imply. A significant question, which will be addressed is why such aspects of Bede's work, similar to *DEB* 15.3, have been ignored?

The above two examples intimate a less divisive understanding of a frontier and appear to be Bede's own interpretation, or at least, an interpretation derived from different sources.[35] When Gildas is used, as in I.12, his analysis seems to take primacy. Interestingly both Bede and Gildas' descriptions of the first wall contained the analysis

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[33] *O.L.D.* defs 1-3.

[34] Translation taken from *Ibid*., *EH* I.11: Habitabant autem intra uallam, quod Seuerum trans insulam fecisse commemorauimus, ad plagam meridianam, quod ciuitates, farus, pontes, et stratae ibidem factae usque hodie testantur; ceterum ulteriores Brittaniae partes, uel eas etiam, quae ultra Brittaniam sunt, insulas iure dominandi possidebant. In line with *O.L.D.* def. 2.

[35] Tac. *Agr*. 19-21 recounts the inclusive actions of Agricola. *Agr*. 23 discusses the Forth-Clyde isthmus as a frontier within the province, *inventus in ipsa Britaniia terminus*. As with the norms of Tacitus' time, this 'frontier' is porous: *Agr*. 25 discusses operations north of the Forth, *amplexus civitates trans Bodotriam sitas*. These sections may have contributed to Bede's less divisive understanding of frontiers.

that its turf construction was of little use.[36] If this was the case, why is the same accusation not levelled by Bede at the turf-built Severan Wall in I.5? This may demonstrate the use of different sources in compiling the *EH* and shows that its statements, as with those of Gildas, cannot be taken at face value.

EH I.12 goes on to discuss the second, stone, wall in exactly the same terms as Gildas. The same examples and principles are cited wholesale: it was to be defended from the top, be divisive and defend against the hordes to the north. This is, however, to no avail:[37]

> '[The Irish and the Picts] captured the whole of the northern and farthest portion of the island as far as the wall, driving out the natives. There the Britons deployed their dispirited ranks along the top of the defence and, day and night, they moped with dazed and trembling hearts. […] The cowardly defenders were wretchedly dragged from the walls and dashed to the ground.'

Indeed, whenever Bede refers to the Wall, it is always in this context of defence. *EH* III.2 is a prime example of this:[38]

> 'The place, on its north side, is close to the wall with which the Romans once girded the whole of Britain from sea to sea, to keep off the attacks of the barbarians as already described.'

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[36] *EH* I.12: […] *ad nihil utilem statuunt*; [the Wall] was built to no use. *DEB* 15.2: […] *non profuit*; [the Wall] was not useful.

[37] Translation in McClure & Collins, 1994. *EH* I.12: [Scotti Pictique] omnem aquilonalem extremamque insulae partem pro indigenis ad murum usque capessunt. Statuitur ad haec in edito arcis acies segnis, ubi trementi corde stupida die noctuque marcebat. […] Insequitur hostis, adcelerantur strages cunctis crudeliores prioribus.

[38] Translation in McClure & Collins, 1994. *EH* III.2: Est autem locus iuxta murum illum ad aquilonem, quo Romani quondam ob arcendos barbarorum impetus totam a mari ad mare praecinxere Brittaniam, ut supra docuimus.

These examples clearly repeat Gildas' polemical context. This makes the *Historiam Ecclesiasticum Gentis Anglorum* an easy source for ancient support of functional, military orientated discussions, despite the subtle hints in the text that a non-polemic work had a different interpretation.

§ 2.3 | The Victorian Era: Nations, Borders and Frontiers

The Victorian era exerts a huge influence on the study of Roman frontiers and, in particular, the Wall itself. This is illustrated by the work of J. Collingwood Bruce, whose *Handbook to the Roman Wall* recently made its 14th edition, having been first published in the Victorian period.[39] Victorian scholars drew heavily upon their own time making direct parallels between the British Empire and Rome.[40] This process was not, however, a new innovation. Indeed, such contemporary influence in the study of the Roman world had been ongoing since the late-16th century[41] and was centred on the definition of national boundaries and identities, as well as the barbarian/civlised divide.[42] As will be demonstrated, modern scholarship has often engaged in a dialogue with the Victorian era, consequently this section will concentrate on works from, or heavily influenced by, this period. Discussion in this section focuses on two key questions: what effect did the British/Roman empire parallel have on the interpretation of the Wall, and why did this process occur?

During this period, frontiers were seen as a line-in-the-sand separating one group of people from another. This was usually characterised as civilised on one side, and barbarian on the other.[43] Instrumental in this concept is that of defence, the barbarian was to

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[39] 14th Edition, edited by David Breeze, published 2006; 1st edition, published 1863.

[40] Hingley, 2000, 21; James, 2002, 8.

[41] As shown by the anonymous Elizabethan quantitative survey of the 'Pightes Wall', §1.3.

[42] See Hingley, 2008, Chp.3 for in-depth discussion of the late-16th to late-18th centuries influence of Hadrian's Wall.

[43] Whittaker, 1994, 2.

be stopped from endangering civilisation.[44] This is made clear in Kipling's 1906 children's work, *Puck of Pook's Hill*, where Hadrian's Wall is used to hold back the raiders from the seas and the north.[45] His co-authored work with Fletcher of 1911, *A History of England*, is perhaps more explicit as it envisages Roman Britain 'asleep' behind the Wall.[46] However, Kipling, certainly in *Puck of Pook's Hill*, is providing allegory whereby historical accuracy is not the aim; he may even have been aware of how influenced he was by his British Imperial experience.[47] These two examples, one of which a children's book with the other a school history text, show how prevalent the application of contemporary ideas to ancient structures was and how this was used to build knowledge of Rome from an early age. What of more academic work, how does the context of the day manifest itself?

The simplistic, divisive view of frontiers outlined above has its roots in the rise of the nation state. Central to this concept is that of one state exerting primacy over another. Importantly, in the Victorian era, this included other races.[48] This is more closely related to the Victorian age than that of the Romans who have no overarching concept of race.[49] The nation state is connected to the dovetailing of races and territory thence to borders.[50] This connexion did not exist in the Roman-era as people were not conceptualised as belonging to land and territory in the same manner:[51] how could Rome dominate other nation states when no such entity existed?

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[44] Whittaker, 1994, 1; Pelham, 1911, 169-70; Kipling, 1906, 154 in Hingley, 2000, 44.

[45] Rivet, 1976, 5. 'On the Great Wall' and 'The Winged Hats' are the short stories dealing specifically with this.

[46] Fletcher & Kipling, 1911, 22. Fletcher's writing was doubtless influenced by Kipling's poetry.

[47] Rivet, 1976, 13.

[48] Vance, 1997, 5.

[49] Hingley, 2000, 50.

[50] Febvre quoted in Whittaker, 1994, 7-8, stresses that military borders and territorial boundaries did not merge until the 18th century. This again stands against a solely military understanding of Hadrian's Wall. Even the concept of a 'natural frontier' does not begin to develop until the 14th-17th centuries. Whittaker, 1994, 3-4.

[51] For example, provincial revolts in Pannonia, Dalmatia and Judaea are considered 'foreign wars' by the Romans, Mattern, 1999, 5.

Perhaps the best example of the dichotomy between the Victorian era and the Roman is the very root of the word 'Imperial', based upon *imperium*. The Victorians considered this to be a reflexion of their territory, over which they had absolute control; the Romans defined it as the right to have military command.[52] The former is connected to land and territory in a way in which the latter is not.

It is this conflation of territory, borders and frontiers, combined with the barbarian/civilisation binary, that creates the need for delimitation and defence. This is neatly underlined by Pelham: 'Delimitation must have been accompanied, or very shortly followed, by defence',[53] and it is this combination of factors that would keep the barbarian, the binary opposite to civilisation, at bay.[54] It is this framework which is applied to Rome and to the study of its 'frontier systems'. This is demonstrated by Pelham: 'The Stone wall and earthworks which mark the northern frontier of the Roman province of Britain form part of the great imperial frontier system by which the barbarians were separated and divided off from Rome and Roman territory.'[55]

Parallels are consistently drawn between the Roman and the Victorian experience of empire.[56] This is applied to structures as much as to debates. A fine example is the Indian Customs' Hedge, Haverfield, writing in the appendix of Pelham's work, makes this explicit connexion between the Wall and the Hedge.[57] However, it may well be the case that, rather than providing a parallel between the two systems, Hadrian's Wall actually influenced it through the circular logic being applied at the time. The functions that the

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52 Vance, 1997, 237.

53 Pelham, 1911, 170.

54 Hingley, 2000, 42-3, 45-6, 58-9. The 'other' can also be connected to races, as mentioned above, again with its own problems of transposition onto the Romans, *ibid*., 50.

55 Pelham, 1911, 164. Interestingly, when discussing the Roman Republic, Pelham notes that Rome did not have any frontiers as there was no way to define them.

56 James, 2002, 8.

57 Pelham, 1911, 333.

Victorians *thought* Hadrian's Wall had are taken as an influence for their own attempts at border security.[58]

This is but one parallel. Julien Guey connected the African fossatum to the French Maginot Line.[59] This model, formulated in 1939 before the outbreak of the Second World War, even likened camels to tanks.[60] Haverfield, speaking at Ambleside in 1913 stressed, correctly, that Hadrian's Wall was not designed to repel mass, large-scale attack.[61] There is a grain of truth in this parallel, the Wall would have been as effective in war as the Maginot Line proved to be. Examples of general parallels between the Victorian and Roman ages include: the Indian frontier in general; Fletcher and Kipling's warnings of luxury; Haverfield's discussion on assimilation; military victories likened to Classical battles; the trenches of the Great War and the decline of military strength through the use of 'foreign' soldiery.[62]

Why is the Roman past used in this way? The connexion of the shared past is important. Britain was once a colony of the Roman Empire and by the Victorian era it was a colonial power in its own right.[63] Lessons, it would seem, are to be drawn from this link, as has already been discussed with the Customs' Hedge parallel. The spectre of imperial collapse that seems to permeate the literature and the mindset of the day draws both positive and negative paradigms. The speeches of M.P. and *Times* writer Robert Lowe were littered with Roman references mentioning the negatives of an authoritarian model of rulership in specific reference to India; as well

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[58] Hingley, 2000, 42.

[59] Guey, 1939.

[60] This model is not Victorian in origin, though the reasoning is rooted firmly in the era of imperialism.

[61] Haverfield & Collingwood, 1914, 434.

[62] General Victorian influence: Whittaker, 1994, 2; decline: Vance, 1997, 230; Hingley, 2000, 33; development of frontiers and fortifications: Vance, 1997, 140; Hingley, 2000, 37, 38, 41, 43, 45, 47; similarity with Classical generals: Vance, 1997, 12; Great War parallel: *ibid*., 223; luxury: Fletcher & Kipling, 1911, 22; Romanisation and assimilation: Haverfield, 1905, 185-6; Hingley, 2000, 53.

[63] Vance, 1997, 237. Given the emphasis on territoriality, the fact that the Romans were physically in Britain is very important.

as stressing the negative and bloody connotations such patronage of Rome's imperial past would inspire.[64]

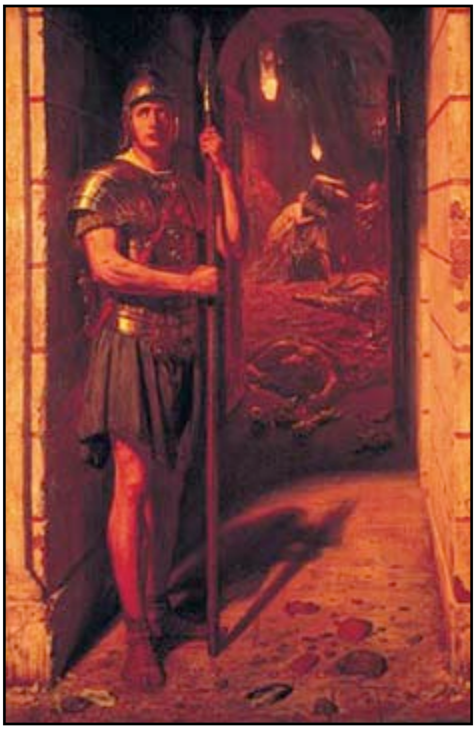

Fig. 2.3: 'Faithful Unto Death', Poynter, 1865.

This use of archaeological materials to support, though sometimes criticise, important aspects of the Victorian world was achieved through imposing supposed values onto the ancient world, and then using this to inform contemporary decisions and discussions.[65] Historian J.A. Froude argued that a shift away from constitutional government in order to better support an empire, as Julius Caesar had purportedly shown in ancient Rome, would be a positive move for Britain.[66] The significant factor in this circular relationship, and one that will be returned to, between Victorians and the classical past, is that the Roman context is completely absent.

Ancient Roman culture is perfect for this relationship, not just for the shared heritage and territory of empire, but for the simple reason that it is dead.[67] It is mute, and thus the carcass is rich pickings for those eager to support their own views. It was not just the literary sphere of Rome that was available, but its physical remains which could be seen around Britain.[68] Hadrian's Wall and other archaeological examples are utilised as much as the historical and Classical record.[69] This cherry picking process, despite ignoring the Roman context, makes their *perceived* culture an active force in the

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64 Covered in Vance, 1997, 229.

65 Hingley, 2000, 52.

66 Vance, 1997, 228. It should be noted that this publication was met with luke-warm reviews.

67 Vance, 1997, 10.

68 Further highlighting how important Rome's possession of Britain actually was in this process. Vance, 1997, 18.

69 Hingley, 2000, 42-3, 47. Poynter's *Faithful Unto Death*, Fig. 2.3 is also part of this process as it shows a Roman soldier at his post in Pompeii. It is a reconstruction based on archaeology, yet it reflects the values of the Victorian era. James, 2002, 8.

Victorian era.[70] Pelham gives another example with his allusion, though not verbatim quotation, to the *SHA* when discussing Hadrian: 'The lines of demarcation which thus 'separated the barbarians' from Roman territory'.[71] This was, fundamentally, a reflexion of the purpose he attributes to Roman frontiers, the Roman outlook is not important; self-confessed is his influence by India, 'Our own experience in India has shown the danger of leaving even picked troops for too long a period at remote frontier stations',[72] thus the most supportive excerpts are chosen and highlighted.

This process results in a concentration on parts of the ancient literature that can be interpreted as divisive, ignoring the non-demarcatory, non-functionally orientated aspects of Gildas in *DEB* 15.3 and Bede's *EH* I.11.[73] Fundamentally, non-divisive aspects do not reflect the Victorian world view and are thus ignored. It is this process that allows Tacitus and Cicero to be conflated by Benjamin Disraeli in order to justify British actions abroad in making sure the 'power and advice of England are felt in the councils of Europe'.[74] Similar Classical misquotations or half-stories were used to justify assumptions about frontiers that say more about the Victorian context than the Roman.[75] This is Kipling's world of allegory, with examples and influences of his own time using the vehicle of Rome for legitimacy. What is needed, is found. The Wall's description in *Puck of Pook's Hill* is overly monumental in order to emphasise that

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[70] Vance, 1997, 4-5.

[71] Pelham, 1911, 161. Another less direct allusion can be found at *ibid*., 164: 'The stone wall and earthworks which mark the northern frontier of the Roman province of Britain form part of the great imperial frontier system by which the barbarians were sparated and divided off from Rome and Roman territory.'

[72] Pelham, 1911, 178, for Indian influence. Birley, 1961, 271, cites an Indian parallel with the frontier soldiers of Hadrian's Wall and the North-West Frontier Levies in India.

[73] §2.2 and §2.2.2 respectively.

[74] Vance, 1997, 230-2.

[75] Whittaker, 1994, 3-4. Bruce, 1851, 35, in discussing Gildas and Hadrian's Wall reveals the attitudes of the mid-19th century: 'When will Saxon and Celt lay aside their differences, and unite for the common weal of Britain! Why should they regard each other with mutual suspicion? Why should the one triumph, and the other sink into hopeless, helpless despair? Creation groans - a prostrate world looks to united Britain and its offshots, for that balm which may heal its woes - let it, strong in the confidence and love of its various constituent parts, faithfully fulfill its duty!' The parallels between Bruce's words and his contemporary, Disraeli, are clear.

this is a state hiding behind its walls; staring into, and being stared into by, the abyss. It is this form of allegory that Kipling stresses in his and Fletcher's children's history book of 1911: 'What a lesson for us to-day!'[76]

Importantly many of these views are couched in military contexts. This relates directly to the class of people who studied the Roman period and formed the administration of empire in the Victorian period.[77] The study of Hadrian's Wall and Roman military archaeology in general has often been the preserve of former military men. This continues through to the recent past, in the shape of Eric Birley, and even the modern day, with the examples of John Peddie and Dietwulf Baatz.[78] This is further demonstrated by the case studies of Donaldson and Luttwak in the following section.

Specific to the case of the Roman Wall, is the nature of interaction with the area and the structure itself. There was a similarity in the methods used to gain control over a region: surveying, road building, fort and camp construction are used by Britain and Rome alike.[79] There was a history of military actions and conflicts in and around the area of the Wall with the Romans providing the last tangible model of when the area was 'united'. These factors were doubtless reinforced by the Victorian ideals of the barbarian/civilisation divide and the association of the Wall with the pre-Union England/Scotland border. The relationship of the military with road building can be seen in the aftermath of the battle of Culloden, which brought military engineers into the region of the Wall.[80] They provided

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[76] Whittaker, 1994, 1, for the view of barbarians waiting to strike. Fletcher & Kipling, 1911, 22.

[77] Wells, 1996, 436, discusses various types of enthusiasts of the Roman past: 'landowners, clergymen and soldiers'.

[78] James, 2002, 10, 19.

[79] Hingley, 2000, 41. It must be noted that there may be a certain amount of circularity here, that the Victorian Britons believed these were Roman methods of control, and so imitated them.

[80] Border: Hingley, 2008, 89; Culloden: *ibid.*, 133-5, 140.

reports on the Roman evidence and, as military men, saw the remains in just such a context.[81]

§ 2.4 | The Modern Age

The manipulation of chronologies, materials and contexts is not only found in post-classical texts and Victorian scholarship. Established upon the seemingly 'clear' statements above, modern values and appraisals appear in more current works. The two clearest examples in post-Second World War scholarship are G.H. Donaldson[82] and E.N. Luttwak.[83] First, Donaldson's appraisal of the Wall shows a clear modern military influence which is evident from the title alone: *Thoughts on a Military Appreciation of the Design of Hadrian's Wall*. He interprets the Wall's interval structures as providing artillery emplacements with:[84]

> […] interlocking arcs of fire covering its whole frontage […] with an unrestricted 360° field of fire [meaning] the Wall itself could be swept by fire from the milecastles and turrets […] this would be similar to that of machine-gun fire on troops trying to negotiate a barbed-wire obstacle […]

It need not be stressed that the 2nd century A.D. is very far removed from a world of machine-guns and barbed-wire. This interpretation shows a retrojection of the modern requirements of a solely defensive structure, which Donaldson presumes the Wall to be.[85] It is not just the structure of the Wall that receives such treatment, the

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[81] Vance, 1997, 239, 240; Hingley, 2008.
[82] Donaldson, 1988.
[83] Luttwak, 1976.
[84] Donaldson, 1988, 131.
[85] Donaldson, 1988, 132, does concede that he has no evidence for his theory: 'Admittedly, there is, as far as I can ascertain, no archaeological evidence […] absence of evidence, however, is not conclusive evidence of absence.'

organisation of the Roman military is assumed to contain specialised soldiery. In this instance specific artillery regiments are presumed:[86]

> If there was pressure on legionary manpower, the allocation of *tormenta*, perhaps even on a temporary basis, to crack units of *auxilia* is certainly not impossible.

Donaldson's analysis fits into a far larger corpus of work, often by former military men which apply modern concepts to the ancient world. Luttwak, a senior American strategist,[87] wrote *The Grand Strategy of the Roman Empire* in 1976 during the Cold War. His analysis is redolent with the era, and parallels between Rome and N.A.T.O. countries can be seen throughout. Fundamentally, the 'sameness' of the past is seen in this work:[88]

> We, like the Romans, face the prospect not of decisive conflict, but of a permanent state of war, albeit limited. We, like the Romans, must actively protect an advanced society against a variety of threats rather than concentrate on destroying the forces of our enemies in battle. [...] The paradoxical effect of the revolutionary change in the nature of modern war has been to bring the strategic predicament of the Romans much closer to our own.

This excerpt demonstrates the effect of the wars in Vietnam and Korea. Saigon had fallen a mere year before the book's publication, demonstrating that threats cannot necessarily be removed by body count alone. Similarly, the Korean War allowed superpowers to

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[86] Donaldson, 1988, 132. Luttwak, 1976, 45, speaks against *auxilia* having any artillery as this would contradict general Roman strategy. Interestingly he cites the modern parallel of the Indian Mutiny of 1857, demonstrating the permeation of Victorian thought, supra, right through to the 20th century.

[87] At the time of writing Luttwak is based at the Center for Strategic and International Studies in Washington, D.C. He has also acted as a consultant to the US Secretary of Defense, the National Security Council, the State Department, the US Army, Navy and Air Force as well as N.A.T.O. allied defence ministries. Luttwak was born into a Jewish family in Romania and raised in Italy and the United Kingdom.

[88] Luttwak, 1976, xii.

clash militarily within a limited theatre.[89] James discusses this 'sameness' in the literature of the 19th century,[90] however, it is equally valid in the cases of Luttwak and Donaldson. Where Donaldson sees machine-guns and barbed-wire on the Wall, manned by specialised artillery trained soldiery, Luttwak sees Roman strategy as being similar to Cold War era ballistic missile defences. He sees the security situation in 1970s Israel as being 'a very exact parallel' for Rome's borders; Napoleon's administrative policy shadowing Rome's and, as with Guey before the Second World War, frontiers discussed with reference to the Maginot Line.[91] In part this 'sameness' is due to the West being considered the ideological descendants of Rome, with a lineage that included Napoleon. Thus, the N.A.T.O. powers see broad alignment with the 'civilised' half of the barbarian/civilised binary.

With this analogy as a core tenet Luttwak retrojected a plethora of modern military aspects onto the Roman military. Functionally, the Roman military is seen strictly as a fighting force, with any road and camp building used 'in order to avoid the unpredictable risks of rapid maneuver', providing military power 'available to Rome for offensive use'. [92] Some role in civilian construction by the military is accepted, however, the soldiers are described as 'combat engineers'. Despite the example of aiding circus design, no exploration of their role in civic building programmes is entered into.[93] These aspects dovetail neatly with the 'Machine Parallel' in

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[89] This tacitly places regional conflicts as proxies for the struggle between Capitalism and Communism. This binary will be returned to.

[90] Supra, James, 2002, 9: 'I believe that this relationship of past and present subtly altered, and eventually reversed, along these lines: "if we, the descendants/ successors of the Romans, are like them and equally successful in our imperial civilization, then surely the Romans must have been like us".'

[91] Ballistic missile defences: Luttwak, 1976, 61; Israeli parallel: *ibid*., 79; Napoleon: *ibid*., 87; Maginot Line: *ibid*., 80. It should be noted that Luttwak has the benefit of hindsight regarding the Maginot Line, resulting in its use as the ultimate example of defensive folly.

[92] Luttwak, 1976, 2, 19.

[93] Luttwak, 1976, 40.

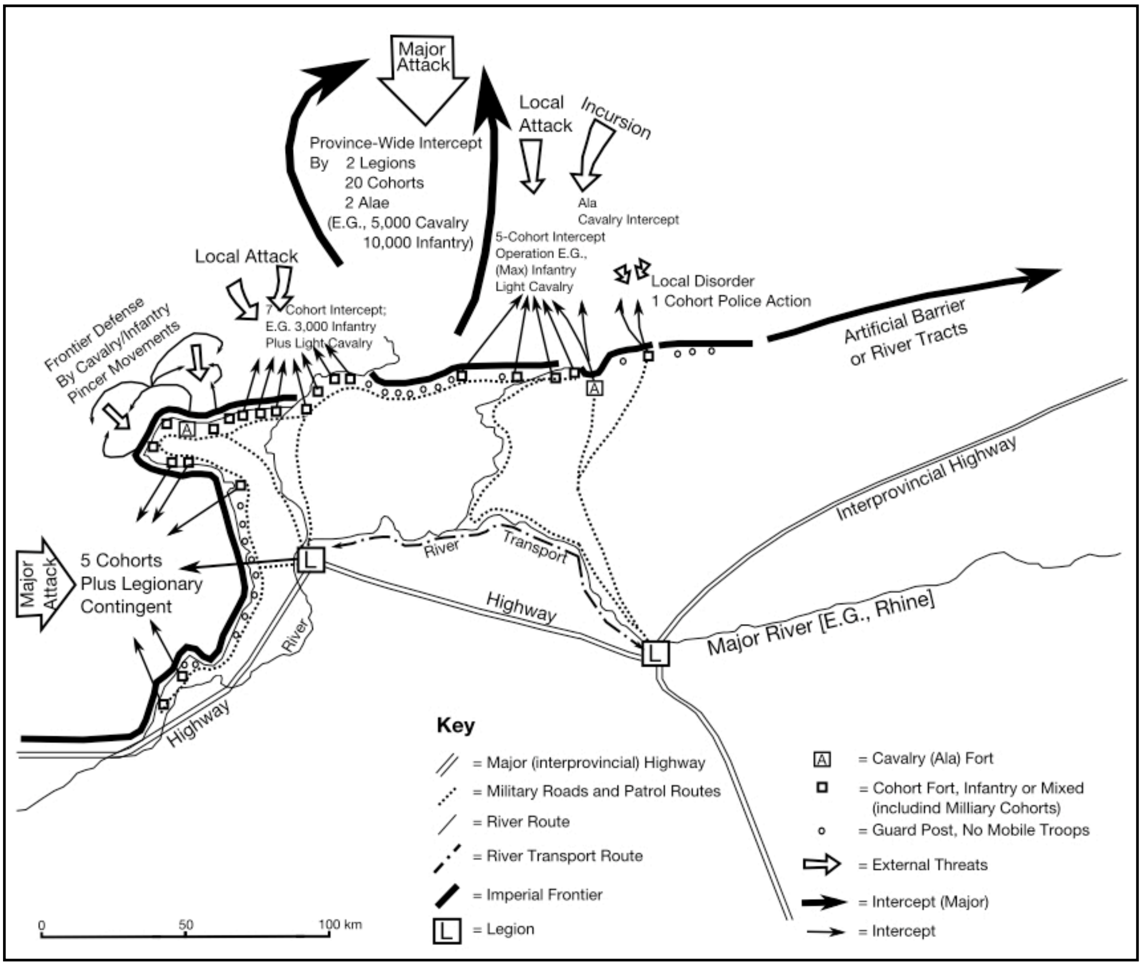

Fig. 2.4: Luttwak's operational diagram of a frontier.

much 19th Century analysis.[94] The specialisation seen here combined with the supposed 'relentlessness' of the Roman army, the hard- and software of 'imperial statecraft' and the utilisation of 'methodical' warfare all contribute to this modern conceptualisation of the army in Luttwak's work.[95]

The sole military function of the army is assumed to provide a screen of security to allow 'Romanization' to occur. Such is the army's focus on combat in these interpretations, their structures, particularly frontier works are given no role in the process of 'Romanization'.[96] That borders are to be defended is a given in this analysis:[97] 'secure frontiers and systematized defenses' are to be

[94] That is soldiers acting like clockwork as part of a much larger, irresistible, war machine, James, 2001, 78; *id*., 2002, 8-9.

[95] Relentless army: Luttwak, 1976, 3; hard- and software: *ibid*., 4; methodical warfare, *ibid*., 121.

[96] Luttwak, 1976, 78, 80.

[97] Luttwak, 1976, 4.

sought, as are 'scientific' frontiers, as demonstrated in Figure 2.4.[98] The Cold War influence in such strategic thought is shown throughout with modernising language: 'buffer states', 'base[s] of operations' and 'surge' tactics.[99] Finally, a modern style organisation is presumed with a Wall Headquarters, based at Stanwix under the *ala Petriana*, and the army as a whole organised into 'fronts'.[100] These occur despite the fact that there is no evidence for a 'Wall Command'[101] and no term for an army or unitary military authority.[102]

Despite the concentration on functionalism, Luttwak does have some consideration of the use of symbolic power by the Romans. However, rather than this being connected to the Roman context[103] it is couched in firmly modern terms. The need for an exploration of symbolic force is seen in light of the Cold War fear of Mutually Assured Destruction (M.A.D.), this is the 'revolutionary change in the nature of modern war' of Luttwak's opening quote at the start of this section. Hiroshima is given as a turning point in the strategic thought of the 20th Century, and the jarring parallel between the Roman use of imagined force, and the threat of nuclear conflict is revealed in Luttwak's analysis:[104]

> The Romans clearly realized that the dominant dimension of power was not physical but psychological - the product of others' perceptions of Roman strength rather than the use

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[98] Luttwak, 1976, 55. No definition of a 'scientific' frontier is given, despite the appearence of the term throughout and its occurrence in the title of the second chapter. Image taken from Luttwak, 1976, 76-7, fig. 2.4. Note the clear divide made by the frontier works. Nothing other than attacks are illustrated beyond. Also, modern language including 'pincer movements', interprovincial highway', 'police actions' and 'interceptions' is used throughout.

[99] Buffer states and base of operation: Luttwak, 1976, 12, 24, 105; 'the system's economy of force': *ibid*., 50; surge tactics: *ibid*., 117. The latter is very familiar from its use in the current Iraq conflict.

[100] Wall HQ: Luttwak, 1976, 73; fronts: *ibid*., 86, Table 2.1.

[101] Breeze, 2006b, 111.

[102] James, 2002, 38-9.

[103] Mattern, 1999, *passim*. places the use of imagined force within a Roman context.

[104] Luttwak, 1976, xi, 3.

> of this strength. And this realization alone can explain the sophistication of Roman strategy at its best.

This understanding is founded on modern concerns revealed in the introduction and reinforces that N.A.T.O. and Rome are alike:[105]

> Above all, the nature of modern weapons requires that we avoid their use while nevertheless striving to exploit their full diplomatic potential.

Similarly, the binary opposition of Capitalism (represented as a 'state' by N.A.T.O.) and Communism (the Warsaw Pact countries) is transposed onto the Roman world. This finds an easy parallel in the barabarian/civilisation divide that can be seen in much analysis.[106] Language mentioning 'primitive peoples beyond the Rhine and Danube'[107] as well as 'sophisticated' peoples in the East[108] highlights this binary. The use of the barbarian/civilisation divide is best demonstrated by Luttwak's discussion of 'Romanization', where those outside the protective screen of Roman linear works were 'living […] in freedom and savagery'.[109]

The paradigm of Rome and N.A.T.O. results in the romanticisation of life under Roman rule precisely because it is associated with life in the Western world. The many uprisings are ignored[110] with the 'tranquility of vast territories' mentioned. Paradoxically, the Jewish War and the siege of Masada are mentioned almost immediately after this statement.[111] The security and prosperity present in N.A.T.O. countries is passed onto Rome, resulting in Luttwak's idea

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105 Luttwak, 1976, xii.
106 Pelham, 1911, 161, 164, 172; Hingley, 2000, 42-3.
107 Luttwak, 1976, 20.
108 Luttwak, 1976, 32, 33, 47.
109 Luttwak, 1976, 78.
110 Mattern, 1999, 5.
111 Luttwak, 1976, 1, 3.

of 'self-Romanization'.[112] This says more about Luttwak's understanding of the Cold War, implying the voluntary spread of Capitalism to the Soviet Bloc were it shorn of Communism. Indeed, this analysis ignores the discrepant experiences, power imbalances and often bloody actions carried out by the Roman military.[113]

Finally, the functional interpretation of the Roman military, born out of the role of the army during the Cold War, dominates interpretation of its structures. The siege of Masada and defeat of the Zealots is described as an 'irrational commitment of scarce military manpower' justified by its demonstration that 'the Romans would pursue rebellion even to mountain tops in remote deserts to destroy its last vestiges, regardless of cost.'[114] Hadrian's Wall, and frontier works in general, are not seen in the same light. Symbolic aspects to their construction are described as being 'wildly irrational given the vast effort needed to build them.' Thus, the symbolic capital gained from actions is not passed over to structures by Luttwak.[115] This solely functional reading of military structures meant that they could not be proxies or abstractions of the state's power, nor could they serve any purpose other than military.

§ 2.4.1 | Customs Barriers

These exemplars of military models have been heavily critiqued. Both Luttwak's and Donaldson's theses were reviewed by J.C.

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[113] Mattingly, 2006, 199. Many provinces needed to be conquered repeatedly, including Pannonia, Dalmatia, Judaea, Armenia, Mesopotamia and Assyria. Mattern, 1999, 5, 103-4.

[114] Luttwak, 1976, 3-4. Interestingly, this takes place in the East; despite his belief that 'the client rulers of the East and their subjects were, as a rule, sufficiently sophisticated to understand the full potential of Roman power in the abstract, while the peoples of continental Europe often were not', *ibid*., 32-3, 47. Furthermore, Masada was a highly contentious excavation pursued for contemporary purposes. Consequently, there may be a measure of exaggeration of the archaeological record before Luttwak used this site as a key tenet of his study. See Yadin, 1966.

[115] Even the 'psychological' aspect to camps, and thus forts, mentioned is for the benefit of the soldiery alone. Luttwak, 1976, 55-7.

Mann.[116] Luttwak's broad discussion of frontiers through time betray his commitment to 'military science',[117] the rigid straightjacket which his model presumes is not reflected on the ground. This is described as 'gross distortion' by Mann and highlights this key issue with retrojection.[118] A lack of contextualisation is emphasised as there is no discussion of the Roman Republic. This fails to set the models in their correct context; similarly, the cut-off point in the 4th century results in a lack of consideration for the survival of the eastern Empire.[119] Consequently, Luttwak develops an overly monolithic interpretation of frontiers which fails to account for divergent influences and alternate forms that such structures can take.[120] Similarly, the piecemeal development of frontier works is not reflected in 'grand-strategy' and the idea of defensive structures. Such concepts do not appear in the Roman literature of the time.[121]

Donaldson is criticised for the same lack of contextualisation as Luttwak and his retrojection of modern military thought.[122] The porous nature of the Wall seen with the milecastles, and the Romans' fluid understanding of a border region are also ignored as this does not fit into Donaldson's concept of a modern military frontier.[123] Mann cites the 'mesmerising' nature of the structures as detracting from a contextual understanding of how the army operated in the field.[124] Such criticisms have led to interpretations of the Wall as something other than a defensive line.[125] The idea of

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116 Mann, 1979; *id*., 1990.

117 James, 2002, 9-10.

118 Mann, 1979, 179.

119 Mann, 1979, 180.

120 Mann, 1974, 514; Mattern, 1999, 111.

121 Mann, 1979, 180; Mattern, 1999, 115.

122 Mann, 1990, 51.

123 Tac. *Agr*., 25; Isaac, 1988.

124 Mann, 1990, 54: 'In no way could a competent commander allow any sizeable enemy force to approach the Wall itself. If such an approach took place, then the system had failed. The strictly military defence of the Roman occupied area would have been just as efficiently secured if Hadrian's Wall had never existed.'

125 The idea's progress is charted by Simpson, 1976, 21-2 and Daniels, 1979, 360.

control of movement was first suggested by R.G. Collingwood in 1921 with his appraisal that:[126]

> [The Vallum] was not a defensive work but a frontier-mark, a line indelibly impressed upon the earth to show the wandering native where he might not go without accounting for his movements. […] The Wall took the line of the crags not for tactical reasons but in order to increase the outlook of the sentries; for in essence the entire structure was an elevated sentry-walk […] Anyone who had good reason for coming in could come through the forts or by the gate on Dere Street at Stagshaw Bank.

Eric Birley expanded the idea in 1956[127] and concretised the concept in his seminal *Research on Hadrian's Wall*, emphasising the fiscal aspect: 'I have drawn attention to the close connection even at the planning stage between the construction of artificial frontiers and the economic development of frontier zones.'[128] These theories appear to be a reaction to the overly systematic nature of the Wall which erodes its military value, the Wall was not especially high and was lightly garrisoned with 70-80 men per km. Furthermore, the rigid regularity of the interval structures leave little room for variation according to local circumstance.[129]

Mann further elaborated the non-military functions in 1974 by contextualising Roman military operations of the principate[130] and aligning frontiers with an administrative role:[131]

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[126] Collingwood, 1921, 8-9. A wall-walk is still presumed in this period.
[127] Birley, 1956, 25-33.
[128] Birley, 1961, 269-75.
[129] Dobson, 1986, 5-7. Militarism is promoted by Birley, for example with his 'Wall like' spread of 'Outpost' sites. See §8.2-3.
[130] Mann, 1974, 510, 514: 'The gods gave given the Roman *imperium sine fine*. The occupation of the *orbis terrarum* was a forgone conclusion. It was only a matter of time. Static frontiers have no place among such attitudes. […] The weakness of the frontiers was of course contained in their very existence. They were all, in the long run, unsuccessful - because they were there.'
[131] Mann, 1974, 512.

> As the line acquired increasing definition, it required an increasing degree of control, not only for minor bureaucratic functions like customs-collection and the prevention of smuggling and cattle-raiding, but also and more importantly for the political control of movement across the line, particularly in order to reduce contact between dissident elements inside the empire and hostile elements outside. On the one hand was a bureaucratic job that needed to be done, on the other a body of men who in normal times now had nothing strictly to do.

The economic role of the military was emphasised in this interpretation:[132]

> The economic impact of the permanent stationing of contingents of 500 or 1,000 men (or in the case of legions, 5,000) must have been enormous. […] Each unit in fact constituted a large and, more important, continuing market.

Consequently the defensive worth and deceptively military form are discredited:[133]

> It is clear that Hadrian's Wall had neither strategic nor tactical value. […] [The Roman army] deprived of continued employment in [the] field, was given instead a necessary but much inferior role. Flinging its great energy and an enormous amount of time into the work, is it surprising that it could produce over-elaborate and unnecessary structures like Hadrian's Wall? Is this not what psychologists define as 'displacement activity'?

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[132] Mann, 1974, 516.

[133] Mann, 1974, 531-2. Conceptually, this relies on a similar strict military/civilian divide as the modern world, which would see the Roman military responsible for little other than combat in the field.

However, such customs and administrative aspects were not widely applied to the Wall until Breeze & Dobson adopted the term 'non-defensive barrier' in their description of the Wall's function.[134] This caused the book's reviewer, Daniels, to conclude:[135]

> Further: to call a linear rampart, at least 15 ft. high, and wide enough to allow its use as a fighting platform, defended by a ditch with a counterscarp to the north, crowned by towers and small posts every 540 yards, and with no less than 17 major forts, holding a garrison of *c*.10,000 men ranged along its length - to call all of this a non-defensive barrier may, by some semantic play, be possible, but in military terms it is surely a nonsense.

Dobson, in the Seventh Horsley Lecture, clarified the stand point with the Wall 'not intended to play a major role in battle'. Importantly, Dobson introduces the concept of a multi-role military force, with its structures, despite their expected military appearance, reflecting the military's multiple functions.[136] Consequently, the subsequent editions of *Hadrian's Wall* have refined the delivery:[137]

> Hadrian's Wall was a barrier, not a fighting platform […] the Wall was to control movement into and out of the province […] but it was not the provincial boundary.

The Wall, however, does lend itself to military interpretations. Richmond, Figure 2.5, Baatz and Woolliscroft all produced detailed theses on how frontiers would function militarily.[138] There is no such

[134] Breeze & Dobson, 1978, 143 take account of the criticisms for a solely military interpretation laid out in Collingwood, 1921, 4-6.

[135] Daniels, 1979, 360.

[136] Dobson, 1986, 7: 'The responsibilities laid on the Roman army in the absence of any form of police went well beyond set-piece battles, but not surprisingly the installations they constructed in order to carry out a wide range of duties retained a military form.' This is in line with James' emphasis on the lack of a military/civilian divide in the ancient world, 2001, *passim*; and Mattern's stress that modern divisions need not have occurred in the ancient world, 1999, 22.

[137] Breeze & Dobson, 1987, 145. The fourth edition, 2000, maintains this description.

[138] See Dobson, 1986, 23 for Richmond and Baatz; Woolliscroft, 2001, 58-102.

clear 'statement of case' for the Wall's fiscal or administrative dimensions.[139] Furthermore, issues with the placement of milecastles cast doubt on the idea of the customs barrier as the Wall's *raison d'être*. The milecastles facing steep crests with blocked gateways serve no functional purpose in such models. Similarly, oddly placed milecastles, such as MC42, which occur mere metres away from well placed crossing points defy the logic of the customs barrier. Woolliscroft's signalling theory appears to solve the strange placement of some of the installations,[140] yet this is a military interpretation and not connected to the customs barrier concept.

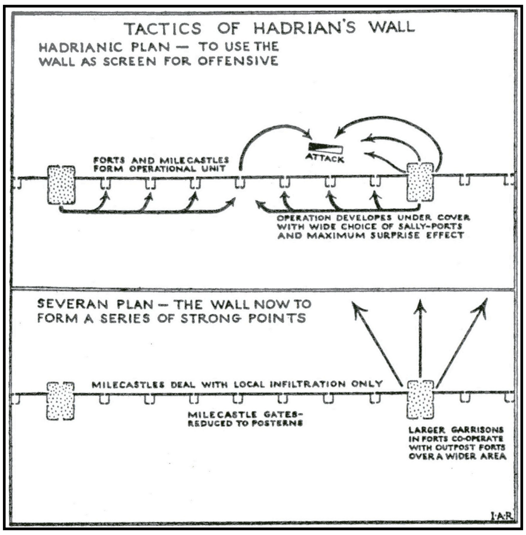

Fig. 2.5: Richmond's operational diagram of Hadrian's Wall.

Without a clear statement of purpose or understanding of function, it is difficult to see the customs barrier as being the only underlying reason behind such a great commitment of labour and resources. This is especially the case given the Roman concept of an impoverished Britain by Strabo.[141] Consequently, the varied theories of function and purpose for the Wall are distilled by Mattingly:[142]

> The intention [of the Wall] was clearly to create a linear barrier for the control of movement through the frontier zone. […] In sum, Hadrian's Wall was probably several things: a huge symbol of power that functioned as an effective deterrent to native aggression and facilitated customs control and frontier supervision. Most importantly, as originally designed, it did not differentiate between Britons to north or south - both groups appear to have been

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[139] Kerr, 1989, is the closest to developing such a model.
[140] Woolliscroft, 2001, 60-6.
[141] 4.5.2-3, cf. Tac. *Agr*. 12.6. See §9.5.
[142] Mattingly, 2006, 156-8.

considered as potential enemies, requiring intimidation and military supervision.

In this interpretation, movement, and not just tax, is given as the reason for the permeability of the Wall, thus the atypical placement of milecastles was to provide control wherever it was required.[143] The symbolic power created by the Wall avoided the costly expenditure of actual force.[144] Security both externally to the north and internally to the south protects the province from threat of invasion and revolt.[145] This encapsulates the 'wide range of duties' the military performed and helps account for the overtly military appearence of the structure.[146]

Whilst this understanding of the Wall accounts for both the varied role of the military and the structures it created, there remains Mann's mesmerisation, not with the archaeological remains of the Wall, but with its function. This concentration does not take into account the effect that these functions had on the people who populated the landscape. That function was not an end in itself is a vitally important factor in understanding the impact and purpose of the Wall.

§ 2.4.2 | Modern Functions; Ancient Needs

Modern, functionally inspired interpretations of Hadrian's Wall created needs that were not the case in the Roman era. Interpreting the Wall like a modern barrier means 'threat perception' is required in order for the Wall to function effectively. Woolliscroft is explicit in his statement that: 'the intelligence screen for Hadrian's Wall was presumably based in the Outpost forts […]'.[147] This is a direct echo of Pelham's assessment 90 years before, with Birrens, Bewcastle and High Rochester controlling territory *in Barbarico*, maintaining

143 Birley, 1956, 25-33; Breeze & Dobson, 1978, 143; Dobson, 1986, 7.
144 Luttwak, 1976, 195-200; Mann, 1979, 176.
145 Mattern, 1999, 103.
146 Dobson, 1986, 7.
147 Woolliscroft, 2001, 80.

both lines of communication and attack.[148] Similarly, Breeze describes one of the functions of the Outpost forts as being to 'give advance warning of attack'.[149]

Modern military and functional readings reflect the modern contexts rather than the Roman. If the Wall was not conceived as a modern divisive barrier, there would be no need for such 'threat perception'. Examples are cherry-picked and used to fill the role required in just the same way as Victorians selected aspects of the literature that supported their world view.[150] The Outpost Forts are just one such example of this.[151] Similarly, models using the Wall as an activity to keep the army occupied[152] require a mono-functional military force, consequently they fail to account for the diverse range of duties that the Roman army had and retroject the modern military/civilian divide. Models for customs barriers and control over movement see these functions as ends in and of themselves, rather than a means to an end which can be revealed by the full Roman context of Hadrian's Wall. They require a world where the day-to-day functioning of a structure is its *raison d'être* and presuppose it upon the Wall.

§ 2.5 | Conclusion: Where are the People?

The above discussion has demonstrated that many of the works dealing with Hadrian's Wall are more concerned with strategy, and the minutiae of the structures, than they are with the effect upon people in the landscape. Function, form and strategy all remove the experience of the individual from the Wall; instead 'grand strategy' or the workings of the structures are considered to be of primary importance. This is further compounded by the nature of modern

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[148] Pelham, 1911, 172.

[149] Breeze, 2006b, 97. The other potential function was to help protect the part of Brigantian territory that had been left isolated by the line of the Wall. Both of these suggestions are functional in purpose.

[150] Supra, §2.3.

[151] See Chp.VIII for more on this.

[152] Mann, 1974, 532; James, 2001, 78-9.

study, which is often a dialogue between Victorian ideals and retrojection, and more modern versions of the same process. For example, the idea of frontier demarcation was a popular theme for the Victorian-era with its concentration on National identity. A.L.F. Rivet's discussion of Kipling's description of a monumental Wall is essentially a debate between a modern scholar and a Victorian analysis. Rivet's rebuttal, however, is still couched firmly in functional terms: 'it is clear that [the Wall] was originally conceived as a line of frontier demarcation'.[153] This interpretation is not dissimilar from Pelham's exhortations that: 'the first step in the construction of a frontier must have been delimitation.'[154] Shadowing such interpretations is Luttwak, who believes that 'the first step was the demarcation of imperial frontiers'.[155] All of these arguments, regardless of era of scholarship, all ignore the example of the Danube, long considered a frontier before a single structure was built.[156] This neatly highlights how such analysis can ignore the context of the Roman era.

Engagement with the structures excludes the experience of people in the landscape, the concentration on form and function is traditionally the only way in which the purpose of the Wall is evaluated.[157] Whittaker stresses the importance of symbolism in his attempts to define a new general framework for understanding frontiers.[158] It is factors like symbolism and the non-quantifiable elements that can have as powerful an effect on day-to-day life as those that can be quantified.[159] This reintroduces people and experience to Hadrian's Wall and is especially important given the complexity of life on Hadrian's Wall. Units from many different, disparate areas of the empire interacted with the diverse peoples

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[153] Rivet, 1976, 11.
[154] Pelham, 1911, 169.
[155] Luttwak, 1976, 57.
[156] Mattern, 1999, 111.
[157] James, 2002, 23.
[158] Whittaker, 1994, 8.
[159] Carl *et al*., 2000, *passim*, Non-quantifiable is preferred to 'non-real'.

already populating the landscape to create a complex, multi faceted environment. Importantly, this removes the function of the structure as the sole reason for its existence. The Wall's operation was just one step on a chain of inferences which reveal the purpose and effect of the structure. The Wall's effect upon this world is a focus lacking in much modern research on Hadrian's Wall. Much work into populating the Wall has concentrated on the epigraphic, sculptural and funerary record.[160] This has led to a static understanding of the Wall's effect upon those populating the landscape. In part this is connected to the nature of research, the focus upon the Roman has led to a comparative lack of work upon the 'native' population,[161] making the Wall's impact difficult to quantify. In considering the intentionality of Hadrian's Wall, and the purpose behind the functions, a clear framework for the Wall's effects upon the landscape can be seen.

This position, however, is not free from bias as it is impossible to write an objective archaeology or history liberated from the contemporary world. This contribution is responsible for repopulating the Wall as a living monument and landscape in an attempt to balance the functional bias in Wall studies. This recreation of a lived space, concerned with agents, experience and symbols, whilst lacking from Wall scholarship, are connected to more general trends in archaeological research.[162] These in turn betray the modern influences of the world around. It is no coincidence that analysis emphasising the liminal nature of boundaries began in an era of national integration in Europe and continues to this day in this work. Similarly, the military bias in Wall studies is placed into a context arising from both World Wars. Scholars with military training and backgrounds, like Donaldson and Eric Birley, are more likely to interpret the structure of the Wall in a military-centric manner. Similarly, with the abolition of National

[160] Summarised in Symonds & Mason, 2009a, Chp.8.
[161] Hingley, 2004, 327; Symonds & Mason, 2009a, 149-52.
[162] Alcock, 1993; Whittaker, 1994; Witcher, 1998; Boyle & Dominik, 2003.

Service in the UK in 1960, the number of people with direct military experience has declined rapidly, seeing the focus shift in academic work away from such areas. More personally, the author lived in Scotland for four years, and is thus keenly aware of the use of Hadrian's Wall as a conceptual, divisive barrier. Whilst such biases can never be removed, the acceptance of their existence allows a far greater freedom in the study, interpretation and impact of any archaeological and historical analysis.

III | Theory and Hadrian's Wall

'What divides the Scythians and the Romans is not a river, nor a swamp, nor a wall - for these one might break through, sail over or surmount - but fear, which no one has ever surmounted who believed that he was weaker.'

THEMISTIUS, *ON THE PEACE OF VALENS*, OR.10.138D

§ 3.1 | Introduction

The Roman military had an underlying, unconscious logic which informed its actions and structures. This chapter sets out to explore this logic by examining the dislocation of the Wall from its Roman context. This is followed by an exploration of the meaning of construction. This includes the power of the act of building, demonstrated by the materials chosen and the effort expended. This army is approached, not as a 'military machine', but as an active force for social mediation in the Roman empire. Whilst the idea of the military as a tool of incorporation may seem to emphasise a peaceful interpretation of the military's actions, it will be stressed throughout that this was a dynamic, often bloody process involving variable experiences and power relations. This process examines the Wall as an active force in social formation that could make abstract concepts, such as labour cost, real.[1] Importantly, the reception of the Roman message carried by the Wall is explored through comparative archaeological study. Thus a measure of the Wall's comprehension by the indigenous population is approached.[2]

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[1] Thomas, 2007, 1, 215.

[2] Whilst this chapter emphasises plurality of experience in and around the Wall, the term 'native' appears. This simply refers to those people who were present before the Roman arrival. It is not meant to represent a homogenised whole, nor is it intended to carry a connotation of being less developed. The term 'Roman' can also be problematic as this implies a monolithic identity that was not the case, cf. Terrenato, 1998, 20; Ando, 2000, specifically 23; Dench, 2005; Mattingly, 2006.

§ 3.2 | Functional Theories

Current understanding of the Wall is couched in firmly functional terms which views the Wall as either a military or fiscal barrier.[3] Neither of these explanations are congruent with the times in which the Wall was constructed. Military theories often rely on close anatomical study of the Wall, extrapolated into a military *modus operandi*. The finest examples of this include both Luttwak's *Grand Strategy of the Roman Empire*, and Baatz's *Eighth Horsley Lecture*.[4] Such interpretations, whilst valid for modern military studies, should not be applied to the Roman era as they are derived from impressions and sources not available to the Romans. Modern maps, for example, provide a top-down, 'bird's-eye' perspective that did not exist in the 2nd century A.D.,[5] and thus could not be used to inform policy in the manner which Luttwak, amongst others, presumes:[6]

> As drawn on the map of the empire at the accession of Trajan, [the eastern] frontier was scarcely tenable […] the depth of territory controlled by Rome was scarcely more than a hundred miles - not enough if the Parthian armies were to be contained.

There are other issues with the strictly military approach. Roman structures themselves are widely recognised as having little defensive value.[7] Many models presume the Wall has a precursor in the Stanegate, the military failure of which resulted in the dramatic solution provided by Hadrian's Wall.[8] However, the staccato nature

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[3] Military divide: Pelham, 1911; Luttwak, 1976; Daniels, 1979; Donaldson, 1988; Woolliscroft, 2001. Customs barrier: Collingwood, 1921, 8-9; Birley, 1956, 25-33; *id*., 1961, 269-75; Mann, 1974, 512; Breeze & Dobson, 1987, 145. See §2.4.1.

[4] Luttwak, 1976; Baatz, 1997.

[5] Dilke, 1985; Austin & Rankov, 1995, Chp.5; Mattern, 1999, 24, 26.

[6] Luttwak, 1976, 107. Hodgson, 2000, *passim*, concentrates on the development of the Stanegate as a frontier by analogy to Danubian installations of the same era.

[7] Mattern, 1999, 113. Collingwood's 1921 critique attacks the idea of the Wall as a military barrier. Whilst he believes a wall-walk to be in existence, the Wall's military value is further undermined by its lack.

[8] See §1.1, Chp.5 and Hodgson, 2000 for in-depth analysis of this view.

of development on the frontiers undermines the idea of a coherent system of defence.[9] The development of the German *limes* undermines the idea of the Stanegate as a Wall precursor: *ad hoc* development in one area would not produce a coherent model of defence planned over a period of 50 years in another.[10] Importantly, fortifications need not necessarily equate to military threat; borders in the modern world can be fortified for any number of reasons: political, social or economic. Similarly, borders may not be fortified at all, the Danube was long recognised as a 'border' by the Romans before the construction of military installations.[11] Just as fortifications need not equal an external military threat, so too the presence of soldiers may not be directly related to guarding and controlling a border: Spain was heavily garrisoned without a geographic frontier.[12] Finally, the idea of 'defensible frontiers' does not appear anywhere in the literature of the era.[13]

The speed at which information could travel in the Roman world further damages the concept of defensive frontiers. In the digital age such considerations are minor; the ancient world did not have the benefit of near instant telecommunications.[14] This directly affects what is reasonable for 'frontier' installations: they are not, to use modernising terms, 'springboards for attack' or 'defence in depth' because the decision making process could not respond quickly to new threats.[15] The soldiers on Hadrian's Wall were far too thinly spread, with a maximum of 70 men per kilometre,[16] to provide any significant resistance to a determined foe. Thus Roman troops were inadequate defence against major incursions as this was not their purpose. Invasions were not to be met at the frontier by

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[9] Mattern, 1999, 111.
[10] Contra Hodgson, 2000. For more on this see Chp. 5.
[11] Mattern, 1999, 111, 114.
[12] Mattern, 1999, 110.
[13] Whittaker, 1994, Chp. 3; Mattern, 1999, 115.
[14] Austin & Rankov, 1995, 125.
[15] Mattern, 1999, 69, 176. There was also little in the way of assessing what those threats were, Austin & Rankov, 1996, 135-41.
[16] Dobson, 1986, 7.

fortifications and field armies, or preempted at the first sign of trouble. Retaliation rather than static defence was Rome's method for combating barbarians and this did not require immovable structures like Hadrian's Wall.[17] This combination of factors demonstrates that the concepts and technology required for such a defensive line did not exist in the Roman era. Consequently, this interpretation represents a modern construct.

What of the other prevailing functional theory, the customs barrier? This would certainly seem persuasive given the military deficiencies outlined above. The Roman military's connexion to the *portoria*, the Roman system of customs and tolls, adds further weight.[18] However, Strabo undermines such a reason for involvement in Britain citing the island's poverty.[19] Whilst this claim may be for political, rather than economic, reasons can the Roman occupation of Britain really be considered a solely fiscal exercise? To consider this question is to consider the wider context of money, tribute and taxation in the ancient world.

Romans considered the extraction of tribute to be deeply onerous. This can be seen in Cassius Dio, where the burden of taxation is given by Boudicca as a key reason to wage war with the oppressive Romans.[20] The Roman understanding, shown by Cassius Dio and placed in the mouth of Boudicca, is clear: tribute and taxation are a

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[17] In many instances, the emperor hears about an incursion long after the governor has repulsed the attack: Herodian 6.2.1, Persian attack; 3.14.1, British revolt; 6.7.2, Rhine/Danube frontier trouble. Rome's response was retaliation, not defence, or an attempt to drive out barbarians as in many cases they would have already left. Mattern, 1999, 69, 117, 122.

[18] Kerr, 1989, *passim*.

[19] Mattingly, 2006, 491. It is worthy of note that Strabo may just be reiterating an Augustan reason for not invading, especially given that emperors would go to great lengths to appear prudent and not be accused of the morally degenerate *aedifictio*, Thomas, 2007, 239.

[20] 62.3.3: 'Have we not been robbed entirely of most of our possessions, and those the greatest, while for those that remain we pay taxes? Besides pasturing and tilling for them all our other possessions, do we not pay a yearly tribute for our very bodies? How much better it would be to have been sold to masters once for all than, possessing empty titles of freedom, to have to ransom ourselves every year! How much better to have been slain and to have perished than to go about with a tax on our heads!'

great enough burden and insult to warrant warfare. The converse is evident in the pride displayed by Romans when extracting tribute. Governors boasted of making new peoples subject to tribute and drawing taxation from territory[21] and Emperors displayed wealth, tribute and plunder in the most public of manners in the triumphal processions.[22] Similarly, barbarians complained that they could only enter Roman territory after paying tribute,[23] showing that control of money was a mark of subjection and superiority in an economic relationship was an important way to mediate status.[24]

Given this use of money, it cannot be said that the Wall's ability to generate income was its *raison d'être*, as this was not the end-product of the process. The Wall was not designed to balance the books of the invasion and military presence, the high cost of the Wall's construction makes it unlikely that this could be recovered in a reasonable period of time. Such an interpretation fails to take into account the symbolic use of wealth outlined here, or Strabo's purported paucity of money-making opportunities in the province.[25] Thus, the use of the Wall to seize money through taxes or tribute was to meet the symbolic goal of promoting Rome's status, of which control of wealth was one aspect. What were the Wall's other symbolic associations?

§ 3.3 | Subjectivity and the Roman Landscape

The Wall must have had a symbolic dimension to its structure. Quite apart from the fact that nothing is ever entirely free of symbolism, it would be impractical to place a structure in a pre-existing landscape already understood by the 'native' population. The result of a non-

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[21] Mattern, 1999, 153, 157-8.

[22] Mattern, 1999, 151-2.

[23] Tac. *Hist*. 4.64: 'The Romans closed river and land, and in a way the very air, that they may bar our converse and prevent our meetings.' Nam ad hunc diem flumina ac terram et caelum quodam modo ipsum clauserant Romani ut conloquia congressusque nostros arcerent, vel, quod contumeliosius est viris ad arma natis, inermes ac prope nudi sub custode et pretio coiremus. Breeze, 2006, 150.

[24] Mattern, 1999, 136, 161.

[25] 4.5.2-3, though cf. Tac. *Agr*. 12.6. Strabo may be excusing the lack of an invasion.

symbolic structure, as functional theories can presume,[26] would be the structure's consumption by the landscape's pre-existing meaning. Key here is that landscape is not merely a set of environmental and economic principles. According to functional and utilitarian theories, easily quantifiable aspects such as proximity to good soils, minimising energy costs and the most defensible sites are the prime movers in shaping how people interacted with their environment.[27] Such an interpretation of landscape misses an aspect fundamental to the world: meaning. It does not take into account the non-quantifiable[28] factors that can have just as great an effect on the behaviour of people as material and functional considerations.

Landscape, rather than being a collection of quantifiable aspects, is constructed internally by people, forming the backdrop of social action. It is therefore an influencing factor on any society which inhabits the same space. However, given that landscape is constructed by those within its confines, the relationship is recursive: being formed by, and forming, society.[29] This gives primacy to actions which take place in the landscape as these have the power to influence social formation. *Praxis*, a social theory by Pierre Bourdieu where day-to-day actions and images reify complex social norms,[30] is vital to understanding how social relations are made, destroyed and perpetuated within the landscape.[31]

Importantly, a key aspect of *praxis* is that control of the landscape, and thus a principal variable of social formation, is vital to affecting

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[26] Donaldson, 1989, makes no mention of any symbolic aspect to the Wall. Woolliscroft, 2001, 64, for example, does see a benefit in signalling's conspicuousness to act as a deterrent.

[27] See Wheatley & Gillings, 2002, 7.

[28] Carl *et al*., 2000, 327. 'Non-real' is used by Carl *et al*., however it is felt here that the use of the word 'real' implies that such concerns are not powerful movers on the way people behave. 'Non-quantifiable' simply stresses that these factors are intangible.

[29] Baker, 1992, 2; Bender, 1993, 1; Witcher, 1998, 61; *id*., 1999, 13-4.

[30] Bourdieu, 1990.

[31] It should be noted that movement is an intrinsic part of the landscape, and will prove to be key, Moatti, 2006, 110.

those within. Clearly power had a hugely important role, whoever could influence the landscape and *praxis* gained authority over the general population and a central role in setting the cultural agenda.[32] Hadrian's Wall should be seen in this light, controlling movement, *praxis* and the landscape with the aim of leading social formation. As will be seen, this dovetails neatly with the end point of the Roman army, the aim of integration.[33] These underlying characteristics of landscapes are applicable to both Hadrian's Wall and the physical space which it occupied.[34] Defining Hadrian's Wall as a landscape means that non-quantifiable factors are as important to the structure of the Wall as they are to landscape studies in general. Fundamentally, the Wall must be contextualised alongside other symbolically-charged Roman structures.

§ 3.3.1 | *Praxis* and Power

Applying *praxis* to Hadrian's Wall expands the effect of the structure beyond merely functioning, be it in a military or fiscal manner. *Praxis* has the power to modify the way the world is perceived; intrinsic to *praxis* is the act of 'doing', action rather than just conceptualisation. A fundamental point of *praxis*, and therefore the construction of social relations in the landscape, is movement and action.[35] Alongside images,[36] the act of doing is a key modifier of people's perceptions and minds.[37] Images and actions entwine in day-to-day *praxis* to 'render palpable infinite kinds of relations'.[38] Control of that

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[32] Barratt, 1997, 56 60-3; Woolf, 1998, 11.

[33] See §3.4.

[34] This is reinforced with the 'artificiality' of landscapes; that is, that they are constructed. There are few structures in Roman Britain as artificial, and as monumental, as the Wall.

[35] Meskell, 2005, 2. Lucian equates the beauty of an audience chamber with the need to speak, in order to become part of its beauty. This, in essence, is a structure involved in *praxis*. Given the role audience chambers take in the political lives of places in the Roman world, *basilicae* and *stoae*, this connexion links into social formation. Thomas, 2007, 230-1. The meshing of the principles of *praxis* to the socially mediated landscape has been termed a 'taskscape', Ingold, 2000, 195.

[36] Favro, 2006, 325.

[37] Moatti, 2006, 110.

[38] Lazzari, 2005, 127. For example, latrines, workshops and paving stones were all considered worthy of divine association in the Roman world. Thomas, 2007, 156.

which forms these relations are key to control of people. As with landscapes, the actions that take place within them is part of a recursive relationship, forming and being formed by the world around.[39]

The net effect of controlling the landscape and *praxis* is highly powerful, it can lead to the harmonisation of thoughts and actions under the same framework.[40] Importantly, this is not a pre-ordained, pre-determined path; it is not conscious. The Roman military's role in creating and integrating new parts of the empire, as will be demonstrated, is the result of the control of *praxis* and the landscape. In Bourdieu's terms, actions that bring about such changes were carried out because, in the Roman framework, they made 'sense'. Their actions were distilled from experience in taking, and subsequently holding, large swathes of land. Eventually, actions simply made 'sense' and became simply what the Romans did.[41] The end-product of controlling landscape and *praxis* is a new norm, a new 'sense'.[42] This creates the screen of socially constructed signs that filters the world and its viewing.[43] Thus the control of images and movement[44] were fundamental to harmonisation and the creation of a new Roman-centric 'sense'. Fundamental to this process was the spectre of change: the landscape, *praxis* and images which maintain, create and destroy social relations were available for appropriation.[45]

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[39] Ingold, 2000, 195; Lazzari, 2005, 130; Meskell, 2005, 3. Lazzari, interestingly stresses that social formations require large-scale spaces for social formation. This is reinforced in the structure of Hadrian's Wall through its monumental straddling of the landscape.

[40] Bourdieu, 1990, 58.

[41] Bourdieu, 1990, 58-9.

[42] It must be stressed that this is not simply a 'Roman' view of the world. As noted Hadrian's Wall is placed in a pre-existing landscape, thus a new 'sense' is a creole between that which the Wall creates and the cultures already in the landscape.

[43] Bryson, 1988, 91, 107.

[44] Bourdieu, 1990, 69.

[45] Obedience, it is stressed by Bourdieu, 1990, 108, occurs when there is more to be gained by compliance than resisting.

How can structures gain this power and its potent effects in influencing social relations? The control of boundaries, both newly-created and pre-existing, is highly important.[46] Boundaries and gateways are symbolically powerful,[47] in their connexion to religious aspects in such diverse ways as the material chosen and the shape of a gateway. For example, *Terminus* resides in stone, thus a stone gateway would be charged with his power.[48] Even the shape of a passage carried religious connotations. The association of vaults with gods, and subsequently emperors, placed heavy emphasis on their importance.[49]

The complex architecture of a gate did not just represent the technical skill of its creators, though that was doubtless an aspect. Rather, the vault, imposts, hinges, panels and threshold all had separate divine powers. Of these, *Ianus* was the supreme deity of the gate. The act of passage, therefore, was highly symbolically loaded as it was a subjection, either voluntary or forced, to multiple Roman gods.[50] Combining the symbolic power of the material and the act of passage, with the linking of distant places and ideas[51] can create a potent combination and a clear indicator of power. This is one example of a process that creates 'identity realms'[52] which would naturally influence those that used them, and, consequently their *praxis* that draws recursively on the landscape.

Vision is an important sense in the creation of such identity realms. Images, ranging from decorations on the side of buildings and pottery motifs through to the buildings themselves, carry the larger

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[46] Mattingly, 2006, 480.

[47] Rykwert, 1976, 136; Evans, 1988, 92. The former describes gates as 'bridges over forbidden tracts of earth charged with menacing power.' Thomas, 2007, 83 discusses Herodes Atticus' use of different woods due to their different connotations. For review of Rykwert, 1976, see Calavita, 1990.

[48] Rykwert, 1976, 107.

[49] Thomas, 2007, 58, 60, 66.

[50] Rykwert, 1976, 138.

[51] Lazzari, 2005, 130. The gods of the structure, as well as those responsible for construction, all hark back to Rome. The materials involved, especially marble, had further associations with imperial power and sanctity. Thomas, 2007, 158-9, 196.

[52] Mattingly, 2006, 332.

social world embedded within them.[53] Vision is often regarded as the most powerful sense[54] and is thus fertile grounds for influence. Ongoing *praxis* within this web of influences, appropriated by Rome, leads to shared opinions, shared ideology and a shared 'cultural vocabulary'.[55] This stands contra to Carl *et al*. who see a tension between *praxis* – identifying this as dealing with the day-to-day practical concerns of life – and ideology.[56] Outlined here is a process whereby the appropriation of *praxis* acts to reinforce ideology.

However, this is not a 'gentle' appropriation, the above is effectively an outline of the end-product of the process, a process which relies heavily on power and control to be able to instigate these events. Controlling the landscape is an important symbol, it shows ability to gain – by whatever means – social power as well as more functional considerations, money through tax and tribute for example, which can then be mediated into displays of strength and authority.[57] Fundamentally this is a display of what one group could do to another.[58] The effect this had on both landscape and people should not be underestimated.[59] The mediation of power through monuments is important for the Wall, its overly systematic and monumental form is noted as functionally impractical.[60] Monuments are the grip of the state on all aspects of civic life that take place around them. In essence, this is the control of landscape, space and behaviour that was manifested in day-to-day *praxis*.[61]

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53 Lazzari, 2005, 142.

54 Fredrick, 2003, 217, 220. Vision is 'the most powerful sense, the sense that extends furthest from [one's] own body.' The fact that the Wall is impossible to take-in in one look will only add to its visual symbolic power. 'For the higher the glance of the eye rises, it pierces with the more difficulty the deneseness of the air', Quo altius enim scandit culi species, non facile persecat aeris crebritatem. Vit. *De Arch.* III.5.9.

55 Moatti, 2006, 134.

56 Carl *et al.*, 2000, 327.

57 Boyle, 2003, 4, sees power and meaning in the Roman context as inseparable.

58 Bourdieu, 1990, 140.

59 Evans, 1988, 93.

60 Dobson, 1986, 6-7; Mann, 1990, 53.

61 Boyle, 2003, 35; Henderson, 2003, 240.

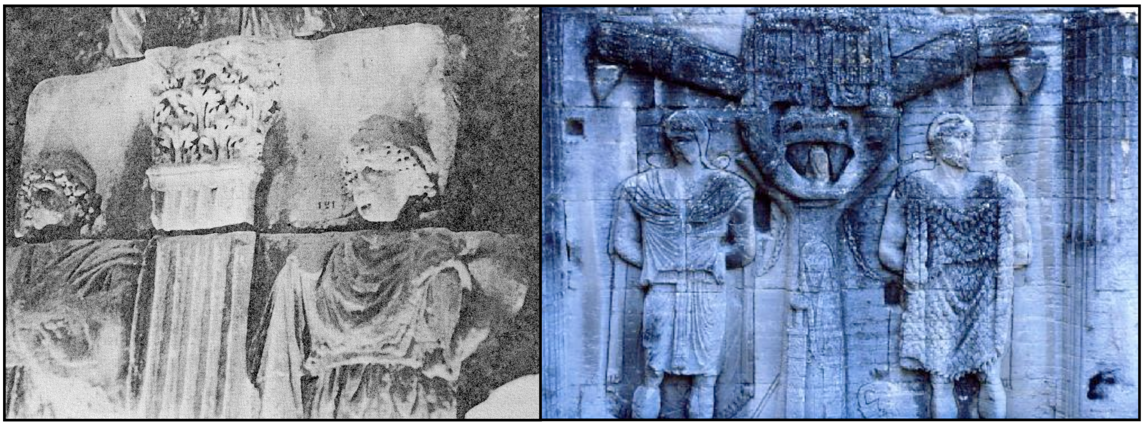

Fig. 3.1: Vienne arch, left, showing Parthian captives; Carpentras arch, right, showing Dalmatian and German captives.

Control is in part mediated through the monuments that appropriate space[62] by the meaning of the structure. The sculptural programmes of various arches in Gallia Narbonensis stress the protective power of the Roman military, those that were depicted as enemies were not just enemies of the city of Rome, but of the people under her protection. This was achieved by portraying the 'enemy' as non-Gallic barbarians, as seen on arches at Carpentras and Vienne, Figure 3.1.[63] This claim of protection also carries latent threat. In becoming a province people had to have either been militarily defeated, as was mostly the case, or surrendered before action took place, as with Asia Minor. The end result was the acceptance of Roman rule and arms, if this had happened once then it may happen again should anyone try to rise against Rome. Space was 'pacified' by Rome,[64] and it is Rome who issues this *pax*. This is the fundamental point of obedience, that there is more to be gained by co-operation than resistance. Structures helped create this acquiescence to Roman power.[65]

Power and its display, as with landscape, is part of a recursive relationship. Actual power, and the appearance of power, shown here through the medium of monumental structures, are

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[62] Though, curiously, not wholesale names. This is in part due to *interpretatio Romano* but also due to the principle of the *genius loci*. The god of a place still has power, even though they may not be Roman. Mattingly, 2006, 42-3.

[63] Ferris, 2003, 47. Dalmations can be identified by their 'Phyrigian cap', which can be seen on the left figure at Carpentras. Parthians can be identified by their different clothing and hair.

[64] Henderson, 2003, 240.

[65] Bourdieu, 1990, 104, 108.

inseparable.[66] Power in the Roman context is intimately connected to what has been termed 'conspicuous visual consumption';[67] the placement of structures in highly visible locations makes them available to many for such a process. Monumentalism legitimised Rome and symbolised both protection and threat. It also altered *praxis* to achieve the goal of promoting a Roman-centric cohesion.[68] Importantly, the monumental nature of such architecture is seen as being reflective of those involved in construction.[69] Colossal buildings implied colossal power and the space for this to occur is provided by well placed architecture: structures formed the canvas of power.[70] This also stresses that symbolic 'capital', to use Bourdieu's terminology, is 'in credit'; a key facet of which is heavy expenditure.[71] The cost, revealed in this study through quantitative survey, was an important aspect of a structure's symbolic power. Consequently much of this thesis is given over to the process of quantitative survey, with Chapters 4-9 heavily using quantitative methodology to demonstrate the symbolic associations of cost.

§ 3.4 | The Roman Context

The above has explored the importance of non-quantifiable factors in the Roman world, it remains to be seen how Rome harnessed this power and extended her rule across the Mediterranean and Europe. This section considers the role that the Roman military played, not solely through functionalism,[72] but as an instrument of state expansion involving concepts other than combat and occupation.[73] The maintenance of the Roman empire seems to have relied on its ability to enforce an image of Rome as awesome and terrifying. This

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[66] Gunderson, 2003, 641.
[67] Bryson, 1988, 108; Packer, 2003, 170.
[68] Evans, 1988, 88.
[69] Thomas, 2007, 150.
[70] Fredrick, 2003, 208.
[71] Bourdieu, 1990, 120.
[72] Chp. 2 and §3.2
[73] This is contra Mattingly, 2006, 128, who sees the army's long term role as occupation. It is the result of such an occupation that is of concern here.

image was rendered in value terms like *decus* and *maiestas*, honour and majesty, communicated via symbols and aimed to inspire respect in allies and fear in enemies.[74] Thus *maiestas* can be defined as Rome's principle way of mediating its status with both allies and enemies. Consequently, actions are not necessarily performed solely for their immediate benefits, but because they are part of a larger process that reinforces *maiestas*. For example, victory in the field is not considered the end-goal of the military, but a necessary step in the process of creating Roman space. This is similar to the collection of taxation as a requirement for its conversion to *maiestas*. Peace is not a goal in itself but rather a means to an end. This end point, it is argued, was primarily the conceptualisation of *peregrini*[75] and the effective taxation, control and creation of a new province that enriched Roman power ideologically, fiscally and physically.[76]

Modern views of the military's role and the over-reliance on functional analyses have created a two-dimensional understanding of the Roman army's purpose in the provinces. This is best illustrated by Breeze, who considers that 'Roman forces in newly conquered territory had two functions, to control the new provincials and to protect them from attack. The Romans were a pragmatic people in both peace and war.'[77] This analysis tacitly accepts that conquered peoples immediately become 'provincials'. Clifford Ando proposes a key role for the Roman military in the maintenance of peace but claims its presence could not account for 'gradual Romanization'.[78]

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[74] Mattern, 1999, 171-2.

[75] *Peregrini* used in the second sense of the Oxford Latin Dictionary, 'individuals or communities who were allowed freedom but no political rights […]', this is an important shift away from the negative connotations of *barbarici*. This could be a conceptual shift as well, rather than solely being the 'legal' aspect it may be that Rome did not consider them barbarians, nor were they considered Roman, rather *peregrini* is a liminal definition.

[76] Hanson & Macinnes, 1991, 87, for taxation; Dench, 2005, for the creation of a new province. Moatti, 2006, 118.

[77] Breeze, 1985, 223.

[78] Ando, 2000, xi.

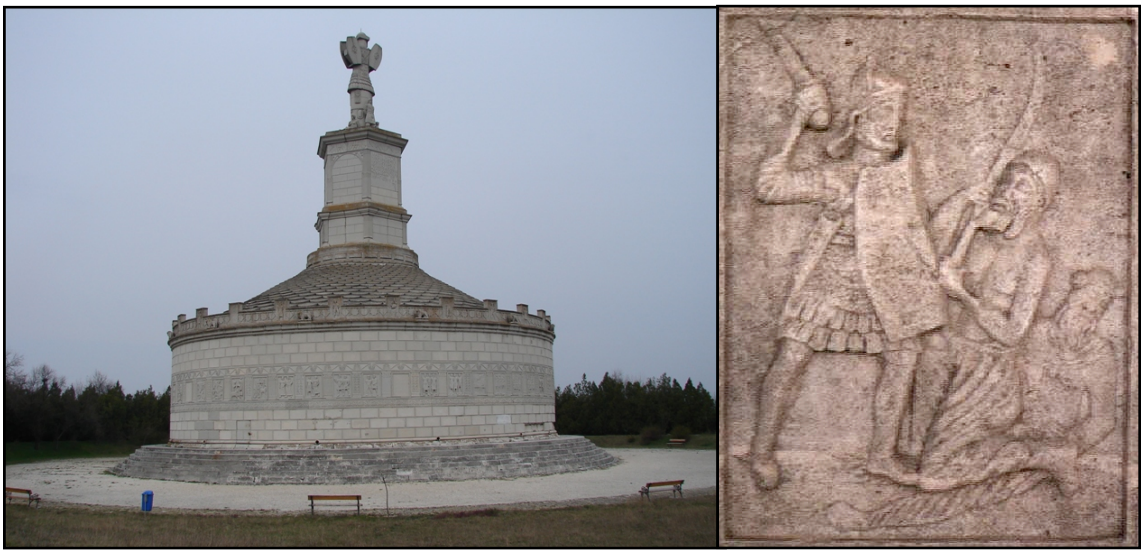

Fig. 3.2: Adamklissi victory monument, left. Detail of Metope XX, right, showing Roman soldier fighting two barbarians.

Contra Ando, it is argued that the Roman army is an intrinsic part in the creation of a Roman province. Ando sees Roman imperial ideology as spreading without a means of mass-communication. Despite this claim, the overwhelming majority of the evidence; coinage, architecture, triumphs, material culture, victory monuments and the road network; was intimately connected to the Roman military.[79] Clearly the Roman military has an active role in disseminating signs of imperial culture and ideology. These signs and symbols of Rome and its empire relied heavily on the idea of *maiestas*. This is loosely defined as 'majesty', and is effectively the repute and esteem of Rome as well as its power. Importantly for the soldiery, *maiestas* is not solely applied to the state, but is also personal. It is defined as 'the majesty of the people or state' and the concept is also connected to conspicuous display: 'majesty of outward appearence, grandeur'.[80] The importance of *maiestas* is underscored by the fact that its lessening is considered a crime, this can be seen when classical authors discuss Roman military defeats, they highlight the damage to the institution of the Legion rather than the loss of life.[81] The manipulation of images and

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[79] Ando, 2000, 19-20. See *Ibid*., 26 coins; 212 architecture; 256 triumphs; 259-61 *vexilla* and *imagines*; 304 victory monuments; 322 roads.

[80] *O.L.D.*

[81] Ferris, 2003, 4; Mattern, 1999, 189.

texts relating to the power of Rome had been an ongoing process since the subjugation of the Samnites.[82]

Representations of defeated peoples are regular motifs and images throughout the empire. They stressed the equivalence of different groups under Rome, and the limitless possibility for Roman expansion through conquest.[83] The finest example of this is the Adamklissi victory monument in modern Romania, Figure 3.2, whose circular design highlights the ongoing and endless nature of Roman victories.[84] Important to this discussion is the prevalence given to representations of Roman soldiers as the Roman state, and captives representing whole peoples. This highlights the military's role in the process and connected them to the propaganda images: the result was that the sight of a soldier, or the image of one, became a proxy for the state's *maiestas*. Thus *maiestas* was one of the principal tools the Romans used for mediating their relationship with 'others'. The status of the 'other' dictates how such structures were received, Cassius Dio, in a speech placed in the mouth of Maecenas advising Augustus, says buildings ought to inspire respect in their allies, with awe and terror the appropriate response from enemies.[85]

The Roman army was intrinsic in the process of both these victories and their subsequent commemoration. However, the military was a very expensive institution. Such factors as the army's pay, its bonuses, discharges and supplies of all kinds required monetary support. Similarly the associated infrastructure, forts and road construction that went hand-in-hand with the military also required heavy investment.[86] This reasoning is a contributory factor to conceptualising Roman invasions, and their subsequent actions, as

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[82] Ferris, 2003, 20.
[83] Ferris, 2003, 60-1.
[84] Ferris, 2003, 72.
[85] Thomas, 2007, 153, 212. Dio Cass. 52.30.1: 'Adorn this capital with utter disregard of expense and make it magnificent with festivals of every kind. For it is fitting that we who rule over many people should surpass all men in all things, and brilliance of this sort, also, tends in a way to inspire our allies with respect for us and our enemies with terror.'
[86] Mattingly, 2006, 493.

relating to a cost/benefit analysis for the military. Despite this, the presence of the Roman military is often considered to be detrimental to the development of *Britannia*. Breeze speaks of the Roman military presence as preventing 'the growth of a genuine economic sub-structure'.[87]

Fig. 3.3: Decoration from the basal plinth of Trajan's Column. Images of booty demonstrate that the Forum complex was built upon the spoils of war.

However, the military's role in constructing forts and *vici* provided 'the most likely and sympathetic environment for social and economic intercourse between Roman and native.'[88] There is no archaeological evidence for a hostile military situation that could prevent economic growth.[89] Consequently, it is argued here that the Roman military was not intended to retard the development of a Roman province, though it must be accepted that this may have been an inadvertent consequence of their presence.

The desire to assess the impact of Rome in solely fiscal cost/benefit terms is undoubtedly a modern construct. Non-functional aspects of Roman monetary behaviour have already been discussed,[90] demonstrating a symbolic aspect to Roman fiscal behaviour. How were these aspects incorporated along the Wall? To the Romans, control of money was at least as important as its function. Money could be translated into *maiestas*, and in the case of the 'customs barrier' argument for the Wall this translation would symbolically highlight discrepant power relations and emphasise Rome's position of power. Importantly, the link between Rome's power and the structure is rendered visually through 'conspicuous visual consumption'.[91] Such visual language is an incredibly powerful tool

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[87] Breeze, 1990, 94. Considered in depth in Chp. IX.

[88] Keppie, 1989, 69.

[89] Hanson & Macinnes, 1991, 85, 86; even militaristic interpretations of the relationship between Roman and 'native' in northern England and Scotland accepts the lack of evidence for conflict, Hodgson, 2000, 12.

[90] §3.2

[91] Packer, 2003, 170. More on this, infra.

Fig. 3.4: Modern day La Turbie, left. Reconstruction of victory monument, right.

as it can be used to control, divide and in some cases incorporate.[92] It can be seen in use at the monumental heart of Rome, in the *Forum Traiana*, Figure 3.3, where the spoils of Trajan's campaigns are used to render an explicit connexion between the military victories won in the field, the monies and spoils generated from the campaign and the *maiestas* of Rome.[93] It was a great source of pride that the known world's income contributed to beautifying the Eternal City.[94]

Such monumental expressions are not solely limited to the heart of the Empire, the City of Rome. Examples of such monuments in the provinces can be seen in Gaul at La Turbie, Figure 3.4, and Saint Bertrand. Importantly, this demonstrated that the projection of *maiestas* was an important consideration in the provinces. As will be seen, this is unsurprising given the bounding of *maiestas* and the

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[92] Ferris, 2003, 4.

[93] Ferris, 2003, 64. Gaius Sosius uses the spoils from the Jewish campaign to commission the Temple of Apollo, another link between military success and conspicuous visual *maiestas*. Ferris, 2003, 37.

[94] Mattern, 1999, 157-8.

purpose of provincial structures, like Hadrian's Wall. In this sense, Hadrian's Wall can be seen to be similar to a victory monument.[95]

The cost of the military must be considered:[96] what methods could have generated money to support the army and are they solely functional in purpose? The recognition that the army was an economic force in its own right can be seen in the structures built from the spoils of its victories. However, it would also be evident on a physical level in Rome with the number of slaves imported to the capital.[97] This, in turn, connects to the triumphal procession, not only are slaves' bodies physically controlled, an important aspect of *praxis*, but this is writ large for whole groups of people whose bodies are under the power of Rome.[98] As with the control of money, so too can the physical control of people be used to mediate *maiestas*. Importantly, this gave the Wall a significance beyond its immediate functional use.[99]

On a provincial level the army's victories supplied money for city walls and gates, which were key indicators of civic pride, identity and *maiestas*. The gateway of Saepinum, Figure 3.5, shows statuary of bound German barbarians and an inscription aligning the construction of the walls and gateways to the Germanic victories.[100] Furthermore, the provinces subsequently created, provided taxation and tribute. The military provided the skill and expertise required for the construction of walls, arches and aqueducts.[101] The army, by

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95 Thomas, 2008, pers. comm.

96 Supra. Suetonius (Vesp. 16.3) estimates that the Roman state require 40,000,000,000 *sestertii* (corrected by some to 4,000,000,000) in order to 'up res publica stare passet'. This is in reference to the restoration of cities, roads, bridges, aqueducts and the Eternal City, Boyle, 2003, 8. All of these have noted propaganda/ maiestas characteristics, for roads see Boyle, 2003, 8; Witcher, 1998; for bridges see Mattern, 1999, 119, 149, 204-5; for aqueducts see Thomas, 2007, 11, 92, 173; city walls and their maiestas/religious power is referred to in this section and in Rykwert, 1976; Thomas, 2007; for such facets in Rome herself see Mattern, 1999; Boyle & Dominik, 2003; Haselberger & Humphrey, 2006.

97 Ferris, 2003, 151.

98 Ferris, 2003, 147.

99 Thomas, 2007, 5.

100 Ferris, 2003, 48.

101 Technical skills are emphasised on Trajan's Column, Rossi, 1971, 99, 101.

Fig. 3.5: Saepinum city gateway. Detail of barbarian and inscription, left; full archway, right.

building forts at key confluences of trade and communication networks, brought civic settlement in a Roman context to important places for the supply of the province, creating rich settlements in the process.[102]

The needs of the army also created a thriving market of opportunity for their supply.[103] Whilst the Roman military was responsible for much destruction, avenues of opportunity were created by the need for rebuilding.[104] These processes would also serve to highlight how important it could be to be 'on-side' with the Romans, those that spoke Latin, for example, had an in-built advantage when dealing with military contacts and contracts.[105] This would serve, albeit unconsciously, to promote the take-up of the Latin language amongst a fiscally-minded sub-set of provincials from recently-conquered lands. Further interaction with the soldiery would be encouraged by the spending power available to them. Once more this would serve as an attraction and a stimulator of production.[106]

The importance of the Latin language can be seen in the literature of the era. This is connected to what the Romans saw as identifiers of their culture. Tacitus' *Agricola* mentions encouragement to the

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[102] Mattingly, 2006, 193.
[103] See Chapter 9.
[104] Mattingly, 2006, 293.
[105] Mattingly, 2006, 294, 512.
[106] Mattingly, 2006, 503.

British elite to adopt the arts, architecture, clothing and language of Rome.[107]

> In order that a population scattered and uncivilised […] might be habituated by comfort to peace and quiet, [Agricola] would […] assist communities, to erect temples, market-places, houses […] Moreover he began to train the sons of the chieftains in a liberal education […] As a result, the nation which used to reject the Latin language began to aspire to rhetoric: further, the wearing of our dress became a distinction, and the toga came into fashion, and little by little the Britons went astray into alluring vices: to the promenade, the bath, the well appointed dinner table. The simple natives gave the name of 'culture' to this factor of their slavery.

Importantly, other than architecture few of these facets are archaeologically traceable or survive only rarely.[108] Interestingly, the occurrence of coinage is not part of this 'cultural package', therefore a lack of presence should not be taken as indicative of a retardation or recession in spread of Roman culture. Undoubtedly the presence and use of Roman coinage was important, especially given the military's role in its distribution,[109] however, other methods of exchange and economic control were available: connexion of

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[107] Tac. *Agr*. 21. Namque ut homines dispersi ac rudes eoque in bella faciles quieti et opio per voluptates adsuescerent, hortari privatim, adiuvare publice, ut templa fora domos extruerent […] Iam vero principium filios liberalibus artibus erudire […] Inde etiam habitus nostri honor et frequens toga. Paulatimque discessum ad delenimenta vitiorum, porticus et balineas et conviviorum elegantiam. Idque apud imperitos humanitas vocabatur, cum pars servitutis esset. Cited by Higham, 1989, 154; Breeze, 1990, 85 in their analyses. See Woolf, 1998, 11 for a list of typically Roman cultural factors; Dench, 2005, Chp.2 for discussion of the incorporative nature of Roman culture.

[108] Inscriptions provide some insight into the linguistic situation, however, the majority of these are military in origin and thus give little indication to 'native' uptake of Latin, Higham, 1989, 155. The Vindolanda Tablets also make reference to native Britons who could presumably interact with the military.

[109] Keppie, 1989, 69. Also Ando, 2000, 314, 411, '[Roman] coins jingled in every market in the empire.'

farmsteads to *vici* via roads,[110] and the presence of imperial imagery at places of barter and requisition could still give control of the economy and its *habitus* without the need for coinage.[111]

Conquest was expected to feed *maiestas* through both economic production and repute gained from success in the field. Furthermore, *maiestas* would be promoted through the manifest building programmes that would accompany such victories.[112] Part of this bounty was the land itself, which could be sold or leased to offset the high cost of military involvement.[113] Having the landscape in Roman hands places it and those within at the mercy of alteration and appropriation by the Romans, a process that can be seen as a prime factor in the appropriation of new provinces. Physical possession of the land also placed its resources in Roman hands. Extraction of precious resources appears to have been important, with gold, silver, coal, brine and salt all seeing relatively swift exploitation by the military in Britain.[114]

As has been stressed, economic exploitation was not the end-product, but enhancing *maiestas* be it through continuous victory or fiscal development was the goal. How did the Roman military build along such lines? There are undeniable similarities between military camps, forts and fortresses and cities[115] meaning that the same symbolic power and context of construction associated with civic structures can be applied to the military counterparts.[116] *Maiestas*,

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[110] Jones, 1984, 84; Hanson & Macinnes, 1991, 86; Witcher, 1998.

[111] Ando, 2000, 212, for portraits in markets. Fronto *Ep*. 4.12.6 mentions the 'moneychanger's bureau' as a place with imperial portraiture, Ando, 2000, 232. Coinage and markets including imperial portraiture reifies the emperors power in connexion to wealth and allows him to guarantee the value of the money, Bourdieu, 1990, 57, 119; Mattern, 1999, 139.

[112] Mattingly, 2006, 491 does not make the connexion to *maiestas*, seeing the monetary exploitation as a goal unto itself. It is stressed, however, the expectation that military success was to equate with pecuniary gains.

[113] Mattingly, 2006, 454.

[114] Mattingly, 2006, 506-7, 510, 511.

[115] Rykwert, 1971, 68-70; Carl *et al*., 2000, 334; Boyle, 2003, 31.

[116] The modern civic/military divide is arbitrary given Roman soldiers would be involved in the planning and construction of civic projects. Campbell, 1994, 120-1; Le Bohec, 1994, 209.

Fig. 3.6: Scenes of legionaries building from Trajan's Column.

symbolic and religious strength, was bound up in walls and gates, these are key parts of Roman military camps, forts and fortresses.[117] The technical skill in their erection is also a key factor in *maiestas*, an aspect clearly shown on Trajan's Column on Figure 3.6.[118]

These military buildings are, by necessity, the first signs of Roman engineering and *maiestas* when the military moves *in Barbarico*. Military victories began the process of appropriation of the landscape. This added to the *maiestas* of Roman military structures, victory was associated with the buildings and personnel of the army and demonstrates that this was not a bloodless process. The sites chosen by the Roman military were often based upon good communications. This would make Roman *maiestas* available to more people and was reinforced by the placement of camps and forts in highly visible areas. The monumental nature of structures such as the Wall connected to the process of appropriation as sheer scale enhanced *maiestas*.[119]

As noted, materials can be of great importance. Hadrian's reconstruction of the Pantheon, for example, involved a Pentelic marble façade,[120] despite the material's paucity, which shared materials between the structure and the Athenian Parthenon. This symbolically reified a connexion between Hadrian and the Greek and

[117] Rossi, 1971, 99; Ferris, 2003, 48; Mattingly, 2006, 331.
[118] Rossi, 1971, 101.
[119] Evans, 1988, 88.
[120] Claridge, 1998, 201-2.

Homeric past. Materials in the landscape could be used to highlight the Roman reordering of the natural world, possibly even its subjugation to Roman rule.[121] Materials of local provenance, including quarried stone as well as locally sourced turf and timber, demonstrated this principle.[122]

Building materials can thus be seen to be an important factor in altering the world-view of people, and promoting incorporation through use of redefined spaces. This process started with the first structure built *in Barbarico* and is supported by the road networks that followed the Roman military. These do not merely act as a conduit for military movement,[123] they connect the new landscape to a network that eventually joined Rome, this connexion is a key concept.[124] When taken in aggregate with the placement and economic role of Roman military sites, they provided stimulus for movement thereby making the spectacle of Roman *maiestas* available to ever greater numbers of people.[125]

This display of *maiestas* was not simply limited to buildings, the skill of the soldiery is also an important aspect.[126] Roman identity, especially that of the Roman military, is intimately connected to *maiestas*. The location of 'sports' grounds outside of forts and fortresses would have placed the technical skill of the army on show to those not in battle.[127] The stimulus for movement provided by the

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[121] Thomas, 2007, 20, 208. This principle is seemingly connected to scale, something which the Wall was certainly not lacking.

[122] Evans, 1988, 93.

[123] Boyle, 2003, 14 sees the Via Domitiana as being a 'political icon'.

[124] Witcher, 1998, passim; Palus, 2005, 185.

[125] Boyle, 2003, 19 sees this as a key factor in the Flavian amphitheatre's power.

[126] Rossi, 1971, 99, 101. Supra, Fig. 3.6.

[127] Such exercising of soldiery could be a powerful symbolic weapon. It is Hadrian's chosen method for demonstrating the military might of Rome, achieving the same result without such a high cost - the terror of the barbarian. Mattern, 1999, 121; Dio Cass. 69.9: 'He drilled the men for every kind of battle, honouring some and reproving others, and he taught them all what should be done […] both by his example and by his precepts he so trained and disciplined the whole military force throughout the entire empire […] This best explains why he lived for the most part at peace with foreign nations; for they saw his state of preparation […] Seeing all this, the barbarians stood in terror of the Romans, and turning their attention to their own affairs, they employed Hadrian as an arbitrator of their differences.'

Roman military would have made this display open to many. Furthermore, the distinctive dress of Roman soldiers highlighted their social position[128] which was underlined by the association of Roman soldiers with the administration of the province, and the civilian courts of law.[129] The effect of this display of difference would not necessarily be inclusive. The reception of the sight of the Roman military was intimately connected to the world view of the viewing agent, which was shaped by *praxis* and socially mediated. Whilst Roman auxiliaries could, and would, be seen as evidence of enfranchisement,[130] there would also be the possibility of a hostile response. Consequently, Roman soldiery should not be viewed solely as agents of *Romanitas*, setting an example for provincials to follow as they ascend the ladder of 'becoming Roman'; but also as agents of *maiestas*, with all the display of power imbalance that this implies.

Maiestas, a key factor in affecting other people, extended beyond the limits of Roman direct control.[131] The appearance of Rome seems to have sent 'shock-waves' through neighbouring societies, Gaul, Germany and Northern Britain all show evidence of this type of response.[132] The result of close contact with Rome was often centralisation in neighbouring communities.[133] This coalescing process, however, was beneficial to Rome as she could always deploy more soldiers, proportionally highly equipped,[134] and highly skilled to defeat a now more centralised power. This response to

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[128] Mattingly, 2006, 199, 206-7.

[129] Mattingly, 2006, 129, 164.

[130] Importantly this connects back to Bourdieu's emphasis on obedience being more worthwhile than resistance, 1990, 104, 108. This opens-up the concept of reciprocal cultural influence to non-elites. Infra, and Thomas, 2007, 6.

[131] Indeed, it is arguable that maiestas forms a way of projecting power further than would be the case without its use. Consequently Rome can affect those that it would normally not be able to.

[132] Ferris, 2003, 24; Mattingly, 2006, 424, 431-2. Roman treaties and diplomacy, it is suggested, will have played a part in the shaping of Ireland, Mattingly, 2006, 524, as will the material culture, Armit, 2007b, 136-7. It must be stressed that this is not the sole response, such external pressure may force societies to collapse, fragmenting rather than unifying, e.g. Ireland's and Britain's different response to Rome, *ibid*., 137.

[133] Keppie, 1989, 71.

[134] Coulston, 1998, 183.

Fig. 3.7: The Sebasteion in Aphrodisias today, left; the new hall built to house the 75 reliefs, right.

Roman power helped facilitate defeat, as one battle was easier to fight than many.[135] The overwhelming nature of Rome's advantage could be used to extract even greater tributes from now more centralised powers. This could have been as important as military victories. Rome fought wars with Persia over the right to crown the King of Armenia, deference to their power and greatness was clearly sought after, and this right was evidently an important symbol of status.[136] Responses to Rome could occur on a variety of levels: the potential surrender of the King of the Orkneys was a response to the latent threat of Rome's appearence.[137] However, wealthy individuals could react by patronising Rome, as seen with the construction of the Sebasteion in Aphrodisias, Figure 3.7.[138] These examples show how Rome could exert a heavy influence through proximity and *maiestas*, not solely through the medium of direct military action. Importantly, the example of the Aphrodisian Sebasteion demonstrates elite participation in Roman culture through the patronage of public buildings. This specific process, whilst allowing mutual interaction between cultures,[139] was only available to the elite.

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[135] It is plausible that this coalescence also made incorporation easier as it brings other societies more in-line with Rome, building commonalities even before their defeat. The building of crannog sites, brochs, duns and wheel-houses all potentially reflect command over surplus labour expressed with prestige structures; key components of Roman *maiestas* which seem to be present in 'native' society.

[136] Mattern, 1999, 176.

[137] Mattingly, 2006, 428.

[138] Ferris, 2003, 56.

[139] Thomas, 2007, 6.

Tacitus' 'cultural package' affected the elite of society and seems to have been a component of Roman imperial policy in the west in order to create a new, Roman-centric, composite culture.[140] The economic realignment would have meant people living around Hadrian's Wall would have been exposed through *praxis* to the economic aspects of Roman rule on a daily basis. This would be combined with the more overt expressions of Roman rule. Consequently, their *habitus* would be affected from outwith, by Roman realignment of the landscape, for example; and from within, by the co-option of local elites.[141] This resulted in the 'native' *habitus* being altered both externally by Roman actions within the landscape, and internally by the reordering of local elites.

The realignment of the landscape through the use of architecture did not solely affect the elites of society. Whilst the military was responsible for much building work in the empire, civilian builders are also attested. The alteration of buildings to reflect a more 'Roman' appearence and the use of Roman architectural norms could thus be seen and worked upon by those further down the social order. The mixing of labour and its effects upon social formation were powerful, and through this process made available to many. This was not without its problems, as the reconstruction of Miletus theatre demonstrates. Here Greek workers objected to the Roman form of the reconstruction, an oracular consultation declared that the Roman architectural forms were acceptable to Athena, the goddess of masons, and Herakles, who symbolised the strength of the arch. The oracle made reference to the 'best man', in effect the emperor. The solution thus created a framework acceptable to all, where Roman architectural norms and their imperial associations were sanctioned by Greek deities.[142] The Romans had their architecture and material culture accepted; the Greeks gained the divine endorsement. Both of these aspects were vital to these

[140] Higham, 1989, 154; Terrenato, 1998, 23-6; Woolf, 1998, 11; Dench, 2005.
[141] Hingley, 2005, 72.
[142] Buckler, 1923, 27-50; Thomas, 2007, 90.

people and both could be accommodated within one structure without excluding the other.[143] This demonstrates the social mediation of two interpretations in one structure.

Such factors aided the process of incorporation into the Roman empire. Whilst the fundamental aim is to create a peaceful and prosperous province it is quite clear that the methods for achieving this could be diverse, highly divisive and outright bloody. The army is present in every step of this process: from conquering on the field of battle, to setting up the transport network. They are intimately involved in the co-option of landscape and *praxis*, the construction of military and civilian works, and the building of settlements and the stimulation of the economy. Emphasising all of these is the army's role in the administration of the province. Intrinsic to this argument is that of *maiestas*, however, it must be stressed that the army in the Imperial period does not operate in this manner with the conscious goal of the co-option of the landscape. Rather, it operates in this manner as it is within the context of the Roman world, in short, to a Roman, the process is unconscious and simply makes 'sense'.

§ 3.4.1 | The Roman Context and Hadrian's Wall

Given that 'construction […] manifested more complex or rarified symbolic concepts'[144] how can this broader Roman context be seen on the Wall? Forts, for example, are not just homes for an effective military force, they are connected to the reified concepts of victories associated with Roman prowess in the field. This reinforced the power imbalance along the Wall, and also refers to the city of Rome itself as it evoked the institution of both the legion, and the auxiliary's process of gaining Roman citizenship. The structure of forts, as with all aspects of the Wall, demonstrated the technical skill of the soldiery responsible for its construction. Hadrian's speech to the *ala I Hispanorum* emphasised the importance of this aspect.

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143 Woolf, 1994, 135.

144 Evans, 1988, 86-8.

Their building skills are praised, architectural materials, especially stone, are emphasised and the fruits of their labours are direct inspiration for military activities:[145]

> You have built up a wall of long stonework [...] in a time not much longer than a wall is built from turf [...] but you [have built it] with huge, heavy, unequal blocks of stone which cannot be quarried or lifted or set in position without inequalities appearing [...]

The importance of displaying this technical skill and the personal *maiestas* of the soldiery was such that it was unlikely that non-military personnel would have been heavily involved in the physical construction of the Wall. However, off-site activities, as well as limited on-site activities like haulage and supervised construction, may well have had non-military involvement.[146] As this was carried out under Roman auspices, it would make the propagandistic message of Roman power and technical skill even more obvious, whilst providing a framework of interaction between Roman and non-Roman with power imbalance at its core.[147]

Structurally, the milecastles show the importance of movement through the structure on symbolic and religious levels. The use of the passage connects to subservience, as shown by the ancient rite of passing under the yoke,[148] and is further reinforced by the physical control over the body the milecastle and its soldiery exerted. Exposure to the many and varied gods of passage was also vital and all these connexions were reified in the daily normal occurrence of entrance and egress. Similarly the structure's function

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[145] Thomas, 2007, 27-8; *ILS* 2487. Hadrian, to the Ala I Hispanorum at Zara, A.D. 128.

[146] Fulford, 2006 discusses the use of non-military labour in construction, however, this appears to be limited as only five building stones provide evidence and they do not state the nature of the work.

[147] The quantification of off-site labour requirements is highly important for calculating the total cost of Hadrian's Wall. See §10.4.

[148] The yoke ceremony was used on Rome after the defeat at the Caudine Forks as a sign of ultimate humiliation. Connolly, 1998, 89.

provided a point of access through the line of the Wall and allowed control of money and its conversion to *maiestas*. This highlights the display of discrepant power that is emerging here as a theme for the Wall. The importance of control of movement is further emphasised when the Wall's ancillary systems are considered, with the Cumberland coastal system's existence to be seen to deter circumvention of the line, and thus force use of the milecastles.[149]

The curtain and fort walls were symbolically connected to city walls as all three were reactions against hostile surroundings.[150] The curtain wall connects to notions of urbanity and civic identity through its similarity to city walls. This is emphasised in Roman-Britain as some forts became the nuclei of civil settlements. City walls themselves were a screen that could communicate a political identity. Walls can be seen as a visual synecdoche for a city itself, and are religiously charged. These concepts would be embedded in the curtain and further reinforced by the forts, *vici* and civilian settlements connected to Hadrian's Wall.[151] Once again the scale of the structure evokes the technical skill of its builders and stresses domination over the natural environment. The parallel running ditch and Vallum further emphasise the conquest of nature through their turf built structure. Furthermore, the tendency for the Wall to be built upon high ground[152] formed a barrier to direct movement and thus emphasised control over the body. This capitalised on the visual and *praxis*-based forms of control. The enforcement of different patterns of movement highlights the importance of the milecastles to the Wall, the imposed movement reified power imbalances structurally.

Whilst the 'horizontal' scale of the Wall is important, the turrets provided 'vertical' emphasis. This made both the structures of the Romans, as well as individual Romans themselves, highly visible.

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149 See Chp. 7.
150 Rykwert, 1976, 48, 68; Carl *et al*., 2000, 334.
151 Rykwert, 1976, 28, 62, Chp.4; Thomas, 2007, 109, 111.
152 Woolliscroft, 2001, 58.

This reinforces the principle of bodily control, as it stretches Roman power both vertically and horizontally, controlling what can be seen. Furthermore, with the close integration and repetition of structures, those wishing to traverse the Wall can always see the soldiers, regardless of where they first see the Wall. The link between the state's *maiestas* in the structure of the Wall and the personal *maiestas* of the soldiery is an important part of the Wall's symbolic message and strength.

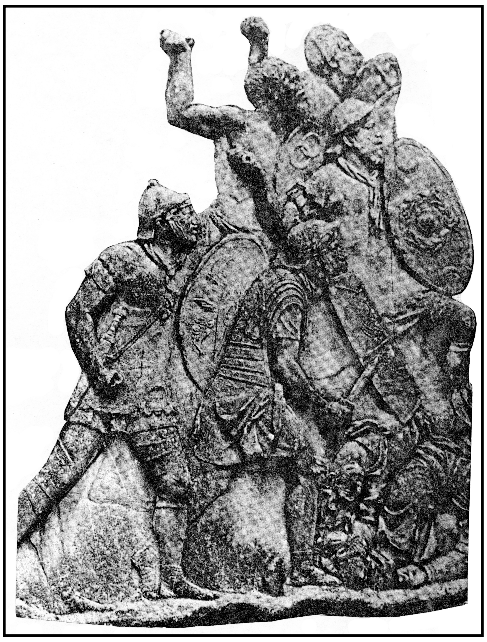

Fig. 3.8: Trajan's Column. Legionary, bottom right, with different ethnic auxiliaries behind and above. The top two units are barbaric looking symmachiarii.

This accounts for the often mysterious close integration of interval structures. Their many, and varied, meanings all contribute to the symbolic whole of the Wall, consequently they are to be seen as a complete symbolic package. This accounts for the repetition of the interval structures, with almost any point in the Wall providing the same structures, and thus the same symbolic message. This shows that the Wall was not merely a random jumble of functional elements, and connects to ideas of the organic whole of architecture.[153] The act of travelling to the Wall would have taken place in a symbolic landscape: the roads, constructed by the Roman military and thus bearing witness to their technical skill, also connected the journey to the larger Roman world.[154] Units stationed on the Wall were from all over the Roman empire, their many and varied provenance alludes to the power of Rome extending across Europe and the Mediterranean basin. This can be seen visually on Trajan's Column, Figure 3.8, where ethnically identifiable units from all over the Roman empire demonstrated that the whole Roman world and its overwhelming might was arrayed against Dacia.[155]

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153 Thomas, 2007, 108.
154 Witcher, 1998.
155 Fig, 3.6 taken from Rossi, 1974, 66, Fig 26.

The use of roads and their materials, which linked the empire together, was a daily *praxis*-based reminder of this connexion.[156]

When passing through the Wall the whole process would be symbolically loaded in order to emphasise control of the landscape. Travelling north-south, the ditch would be crossed first showing Roman control of nature through its symbolic scarring of the landscape;[157] then the stone or turf structures would be passed through, these would have had religious connotations and demonstrate control over natural resources; finally, after the claim of taxation or tribute in the milecastle, where Roman ordering of space would be seen, the Vallum would be crossed, repeating the demonstration of power over materials as well as sheer surplus labour to achieve such monumentality.[158] This was not a random array of elements and materials: 'buildings had a spirit of their own because they were perceived as carefully composed.'[159]

Throughout this whole process, the soldiery is both present and highly visible. The low numbers of soldiers on the Wall should be seen, not as a hinderance to its defensive function,[160] but indicative of another process and connected to the importance of a structure beyond its practical use. The presence of soldiers stops the Wall from becoming empty rhetoric[161] allowing it to attempt to create a new Roman-centric space.[162] They are proxies for Rome itself, just as forts evoke both victories and technical skill, so too the soldiers

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156 For roads creating unity and demonstrating imperial largesse, see Laurence, 1999, Chp.4.

157 Evans, 1988, 93.

158 Whilst the Vallum is a turf built structure, and thus not highly manpower intensive, it's sheer size as well as the complexity of the kerbing render it the second most manpower intensive feature in the sample group.

159 Thomas, 2007, 103.

160 See §3.2. Only 70 soldiers per km is estimated. This may have been as low as 30 per km if the under strength units described in the Vindolanda tablets are normal.

161 Contra Mann, 1990, 53-4.

162 Another example of this can be seen with *basilicae*, especially those in Greek cities, as these monumental Roman constructs serve to organise the city 'by defining its spatial borders and rationalizing its functions'. Such is their role, that alteration of existing *stoa* along Roman lines effectively subverts and reorders space. Thomas, 2007, 22, 138. Sonne, in Thomas 2007, 107, describes the role of architecture as 'behaviour directed at the organisation of the community.'

were responsible for actions in the field and the construction of evocative buildings. This aspect answers the functional problem of low soldier numbers: they are symbolic, maintaining the *maiestas* of themselves, the institution of the Roman military and that of the state. They impose the Wall's symbolic force and allow the structure to function on a practical and symbolic level. How does this affect the landscape, and is a structure like the Wall commensurate with Roman behaviour?

§ 3.4.2 | The Social Environment of the Wall

The area around Hadrian's Wall is often considered 'economically retarded and socially backward'.[163] This is not solely due to the perception of the effect of the Roman military, but also due to the lack of archaeologically visible Roman material culture on 'native' settlements.[164] What governs this lack of material? Most importantly, different types of cultural expression must be considered. For example, the aceramic cultures in mid and north Wales would not start using Roman ceramic pots if they had no cause or tradition for such vessels.[165] Similarly, the lack of coinage occurring around Hadrian's Wall and other parts of Britain may not be indicative of resistance to Roman cultural norms, but be representative of a society without a pre-existing monetary system.[166] This argument, however, risks becoming entirely *ex silentio*; what can be discussed?

Elites are vital for understanding the deliberate actions of the Roman state in its attempts to create provinces. Elites who used Roman goods as part of their own status displays are the most archaeologically visible group. The association of certain goods with

[163] Higham, 1989, 1991.

[164] Hingley, 2004, 328; Symonds & Mason, 2009a, 148.

[165] See Cunliffe, 2005, 117-20; Harding, 2004, 24; Hanson & Macinnes, 1991, 86 for discussion of aceramic cultures. Hingley, 2004, 328 notes: 'to suppose that all sectors of society desired Roman objects and had access to them gives a biased view that focuses upon the influence of Rome (in other words, it is Romano-centric)'.

[166] Hanson & Macinnes, 1991, 87.

Rome, the toga for example, could have given their use prestige value. Of course, other social responses to identifiably 'Roman' goods and customs are possible depending on the acceptance or rejection of conventions.[167] The use of Roman goods makes the adopting group more archaeologically visible, thus the 'Roman' signs are easily recognised. However, the process may be more complex as goods and culture do not exist in a proportional relationship. The connexion of brochs, for example, to architectural elaboration as a status display appears to occur where and when Roman goods no longer had the same prestige value.[168] Whilst architecture is one of the tenets of Tacitus' 'cultural package' it is less uniquely identifiable as 'Roman' than coinage stamped with imperial portraiture. It may well be no less connected to Rome, but simply a different method of status display that was still interpretable as such by Roman and 'native' alike. Reactions to this display would once again be culturally mediated depending on the acceptance or rejection of conventions. The Sebasteion is a fine example of this process, with a local elite dedicating a public monument to Augustus and the imperial family using traditionally Greek norms in a new method of status display through association with Rome.

Elites, centralisation and surpluses are all key facets connected to the creation of a peaceful, functioning province.[169] The process of centralisation may have been catalysed by the pre-invasion appearence of an aggressive Roman military presence.[170] If this was a general reaction to a Roman presence it could be a factor in their success: centralising forces against them, and allowing a convincing single victory to affect more people than would have otherwise been possible. This appears to have been the case in Gaul, where the appearence of Rome led to greater centralisation.[171] This response

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[167] Witcher, 1998, 68; Woolf, 1998, 12-3.
[168] Macinnes, 1984, 242, 244.
[169] Groenmann-van Waateringe, 1980, 1031.
[170] Keppie, 1989, 71.
[171] Ferris, 2003, 24.

may have been conditioned by the high level of conflict in Iron Age Gaul.[172] The Eternal City's location meant that her interactions with other cultures were formed in and around the Mediterranean basin, with those similar in background to herself. The Hellenistic kingdoms, Carthaginian Africa and Spain, and *Magna Graecia*, as well as areas of Gaul were all culturally similar.[173] Were Roman systems of acculturation more effective on those with a similar *habitus*?[174] This may, to some degree, account for the comparative lack of the usual signifiers of 'Romanisation' and 'provincialisation' in non-Mediterranean areas of the Roman empire like Hadrian's Wall and the north of provincial Britain.

Such cultural incompatibility implies an elite which did not adopt the most archaeologically identifiable signatures of Rome. In light of the cultural differences between the Mediterranean world and the north of provincial Britain, it is possible to cite this as a reason for the use of such a dramatic and deliberately 'provincialising' structure as Hadrian's Wall. Whilst the scale of Hadrian's Wall is virtually unparalleled, the underlying logic behind this use of structures is not. Victory monuments in Gallia Narbonensis served as both reminders of Roman conquest and protection through their sculptural programmes, see Figure 3.1, as well as 'Rome's willingness to recognize and reward loyalty', through the patronage displayed by their existence.[175] Furthermore, their presence projects Roman might, in both an offensive and defensive capacity. The deployment

[172] Woolf, 1998, 11-2.

[173] Luttwak, 1976, 32-3: 'The client rulers of the East and their subjects were, as a rule, sufficiently sophisticated to understand the full potential of Roman power in the abstract, while the people of continental Europe often were not. […] Roman military power was freely converted into political power vis-à-vis the sophisticated polities of the East, when employed against the primitive peoples of Europe its main use was the direct application of force'. Groenmann-van Waateringe, 1980, 1041, concentrates on an economic, rather than societal, exploration of the similarities.

[174] Mattern, 1999, Chp 1 discusses the importance of force to the Roman elite, derived from their experiences and educational background.

[175] Ando, 2000, 310.

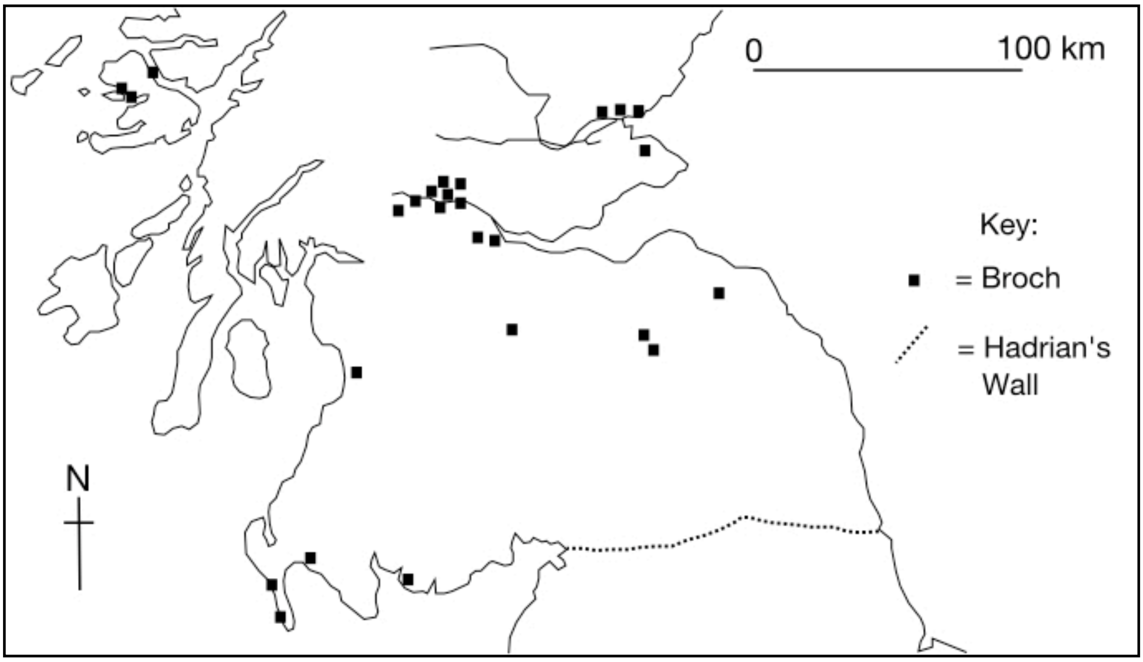

Fig. 3.9: Map of Brochs in southern Scotland.

of such structures along the Rhine spoke of a hope to achieve the same peaceful province in Germany as in Narbonensis.[176]

Clearly a different process occurs in the environs of Hadrian's Wall given the seeming lack of adoption of archaeologically visible identifiers of Roman culture. The archaeology of the indigenous population is examined in the following section, alongside theories proposing a lack of elites, or an elite class that would use Roman material to support status display. Exposure to Roman culture and artefacts may have been limited in the Hadrian's Wall area by the lack of elites living in *vici*.[177] Given the important role of forts and *vici* in providing markets this paucity may be fundamental. However, it may be ameliorated by the close connexion of local settlements to the road networks.[178]

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[176] Ando, 2000, 311, 313. Interestingly, some victory monuments are built by defeated elites, showing once again the will to use Roman forms as an expression of status. The Temple to Caesar Augustus in Lugdunum, Gaul, is just such an example. Thomas, 2007, 6, 127, cites patronage of structures by local elites as a key way of negotiating status on a local and Imperial level. 'Appearing to be Roman' may have been a motivating factor, Hingley, 2005, 105.

[177] Local 'native' elites remain stubbornly hard to identify archaeologically, Woolf, 1998, 8; Hingley, 2005, 75, though there is some very limited inscriptional evidence, Higham, 1989, 155.

[178] Jones, 1984, 84; Higham, 1989, 155; Keppie, 1989, 69; Hanson & Macinnes, 1991, 86; Witcher, 1998.

The nature of 'native' society in north Britain is difficult to assess. Brochs, monumental drystone structures found throughout modern Scotland, are often connected to local elites.[179] Their widespread occurrence, shown on Figure 3.9, can be taken to indicate a high level of fragmentation within 'native' society, and not the centralisation presumed as a response to an aggressive Roman presence.[180] That few members of a society possessed the resources to build brochs perhaps associates their structure with boundedness, exclusion and status display.[181] Atlantic roundhouses, which were not geographically local to Hadrian's Wall,[182] have been interpreted as being connected to concepts of identity formed by isolation, independence and autonomy from other elites of similar standing.[183] These interpretations all imply a lack of centralised 'native' control across the whole area.

However, large hillfort sites like Traprain Law and Eildon Hill North may indicate a greater degree of centralisation. Clearly this emphasises that 'native' society in northern Britain was not monolithic in nature, with a great deal of variation. Consequently, there will be different degrees of social interaction between Roman and 'native', based along alternate lines depending on the type of culture. One may not be more 'advanced' than the other, though some groups may have been more receptive to archaeologically traceable, identifiably Roman materials. These variable groups would have been represented by differing elites portraying status and power in alternate ways. This lack of homogeneity can be tentatively attributed to a lack of military trouble within Britain. The Roman presence need not have been constantly aggressive or static. The lack of direct archaeological evidence for conflict[184]

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179 Breeze, 1990, 93.

180 Keppie, 1989, 71.

181 Sharples & Parker-Pearson, 1997, 264.

182 They are included here in order to provide a wider context for the societies in northern Britain.

183 Armit, 1997a, 266; *id*., 1997b, 249-50.

184 Supra, Hanson & Macinnes, 1991, 85, 86; Hodgson, 2000, 12.

implies a lack of activities which would result in the centralisation and unity of peoples to stand against Rome's arms.[185] It is perhaps for these reasons that Hadrian's Wall was constructed, to integrate the province through an admixture of landscape manipulation and *praxis*, the creation of a provincial 'Roman' *habitus*, and fear.[186]

§ 3.5 | Iron Age Principles and Roman Structures

The functional bias in considering the Wall has not just affected the perceptions of the Romans who built and manned the structure, but also the perception and understanding of the indigenous population of Britain. At times, a Roman military centric interpretation of the 'native' situation is openly accepted or tacit in analysis.[187] This type of analysis, however, is a reflexion of the fact that there is, in the area of Hadrian's Wall, a much greater knowledge of the Roman remains; and courtesy of the written record, a greater wealth of material to draw upon. Whilst this section cannot overcome such bias, it attempts to discuss the all important reception of the Wall by those already living in the area.[188] In short, was there enough in common between Roman and 'native' for the Wall's message to be 'read', and thus, for the structure to be understood?[189]

In order for this question to be approached, the Iron Age landscape needs to be understood as it was into this pre-existing canvas that Hadrian's Wall was introduced.[190] Knowledge of how Rome interacted with Iron Age communities has been highlighted as a

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[185] Keppie, 1989, 71. This is different from the Gallic response to Rome's appearence, Ferris, 2003, 24, which may have been conditioned by the high level of conflict in Iron Age Gaul, Woolf, 1998, 11-2.

[186] Luttwak, 1976, 195-200; Breeze, 1985, 223; Mattern, 1999.

[187] Breeze, 1985, 223. 'It would be possible to examine specific areas to try to determine what the disposition of Roman forces might inform us about native population distributions, native power bases and possible invasion routes.'

[188] Ando, 2000, 212. Whilst Ando considers the reception of artefacts (coins, imperial portraits and posters and standards) this stress is equally important for structures, especially Hadrian's Wall given its aforementioned role as a prime force in attempting to create and maintain the province.

[189] Woolf, 1998, 11-3 gives examples for the use and context of various elements of Roman culture. Importantly, understanding does not necessarily lead to acceptance.

[190] See §9.5.

lacuna in knowledge which few studies have attempted to consider.[191] Consequently, this section will first contextualise the Iron Age landscape, looking at the dominant themes, and how Rome could interact with the 'native' population. Then, three types of structures will be examined: brochs, hill-forts and souterrains; with the potential for comprehension of Roman symbolic messages assessed.

Socially mediated landscapes have been discussed in relation to Rome, however, they are equally relevant for the Iron Age. When examining the effect of a structure the scale of Hadrian's Wall, the whole history of the landscape including non-military settlement and land use must be taken into account in order to understand the effects of its construction.[192] Pre-Roman Britain had been populated for millennia, which led to a highly ritualised, and symbolically significant landscape.[193] Consequently, the landscapes features and structures would have been very important for social formation,[194] especially given the increased population of the era.[195] Physical labour and actions within the landscape would have been some of the primary methods of interacting with the ritual world around.[196] This would have formed a recursive relationship with the act of construction or maintenance as this was required to place and maintain structures in the landscape, which would, in turn, condition those who lived and worked around them.[197]

Consequently, the landscape and its ritualised nature is highly important as interaction with long-standing features from the past, such as ditches,[198] staked a claim of power through association and

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191 Symonds & Mason, 2009a.
192 Gosden, 1997, 305.
193 Armit, 2007a, 30, 36; *id*., 2007b, 135.
194 Gosden, 1997, 304; Gosden & Lock, 1998, 4-5, 11.
195 Armit, 2007b, 132.
196 Gosden & Lock, 1998, 5.
197 Armit, 1997b; Gosden, 1997, 306: 'brochs build people'.
198 Extensions to ancestral dwellings can be viewed in much the same light, Hingley, 1996.

ownership.[199] Importantly, this process meant that the past was an active force in the then-present, and that physical acts and interaction with monuments helped maintain them as part of the dialogue of day-to-day life. This process reaches out across the landscape and effects social formation on a far broader scale when the construction of hill-fort ramparts are considered. The use of seasonal labour, derived from local communities, working upon the construction of these large, multivallate sites[200] meant that a central structure like a hill-fort actually represented a far greater area of control, becoming a declaration of prestige and status, power and territory.[201] The importance the Roman military placed on the display of their technical excellence through construction and maintenance potentially meant that such aspects of Roman structures would have been easily comprehended. Furthermore, the displays of surplus labour which the construction of the Wall helped display, as well as the oversupply of forts and stationing of soldiers, all contributed to a comprehensible symbolic message.

Undoubtedly, the right to work within, and control, this powerful ritualised landscape was vital to Iron Age communities. Thus, conflict would have been embedded in societies as part of their day-to-day lives, and would have been central in social formation.[202] This was because conflict could relate to a varied array of aspects of Iron Age life: trade and exchange, for example, could be a potential source of conflict as different groups vied for control over networks and the alliances that governed such commerce.[203] Control of surplus and the land that would help provide this would have been vital and therefore would have been a source of conflict.[204] These factors connect into concepts of social formation, as greater surplus, which requires greater quantities of land, can result in

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199 Gosden & Lock, 1998, 5.
200 Sharples, 1991, 83.
201 Armit, 2007a, 30.
202 Armit, 2007a, 35; Sharples, 1991, 80.
203 Sharples, 1991, 84.
204 Sharples, 1991, 84-5.

centralisation and the development of larger identities. This is further connected to the ritual landscape, where ownership of surplus-generating land would also grant access to the monuments, structures and ritual associations within the topography. With conflict embedded within society, and, therefore, the landscape, ritualised combat seems to have become part of society, best evidenced by hill-forts and their ramparts[205] whose power over social formation through interaction has already been seen.

It is into this world that first Roman forts, and then Hadrian's Wall was introduced. Rome's desire to co-opt the landscape through structures has already been argued. A corollary of Roman control would have been the Roman *pax* and thus the embedded nature of conflict in Iron Age societies would have been profoundly altered.[206] Given the potential for such differences, it is important to see how comprehensible the symbolic aspects of Roman structures really were. This is carried out through comparative study, considering typical Iron Age structures and comparing their symbolism with those of Roman structures. As noted, the three structures are brochs, hill-forts and souterrains. Whilst the latter two exist relatively close to the site of Hadrian's Wall, brochs are a more northern feature. These structures are included due to their monumental stone nature bearing similarity to the Wall, and their connexion to the broader landscape which is important when considering Rome's interaction with those beyond her boundaries, and the potential of those moving through the Wall from the north.

The core tenets of Hadrian's Wall have been discussed: its prominent placement in the landscape, the symbolic power of its construction and its maintenance through manning, the emphasis placed on passage and crossing, the expression of control over resources and surpluses, the power of *praxis* and the fundamental realignment of the landscape to a Roman cosmology incorporating

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[205] Armit, 2007a, 33-6.

[206] Similarly, the introduction of different trade networks would have created a large difference in pre-existing patterns of trade and exchange. See §9.5.

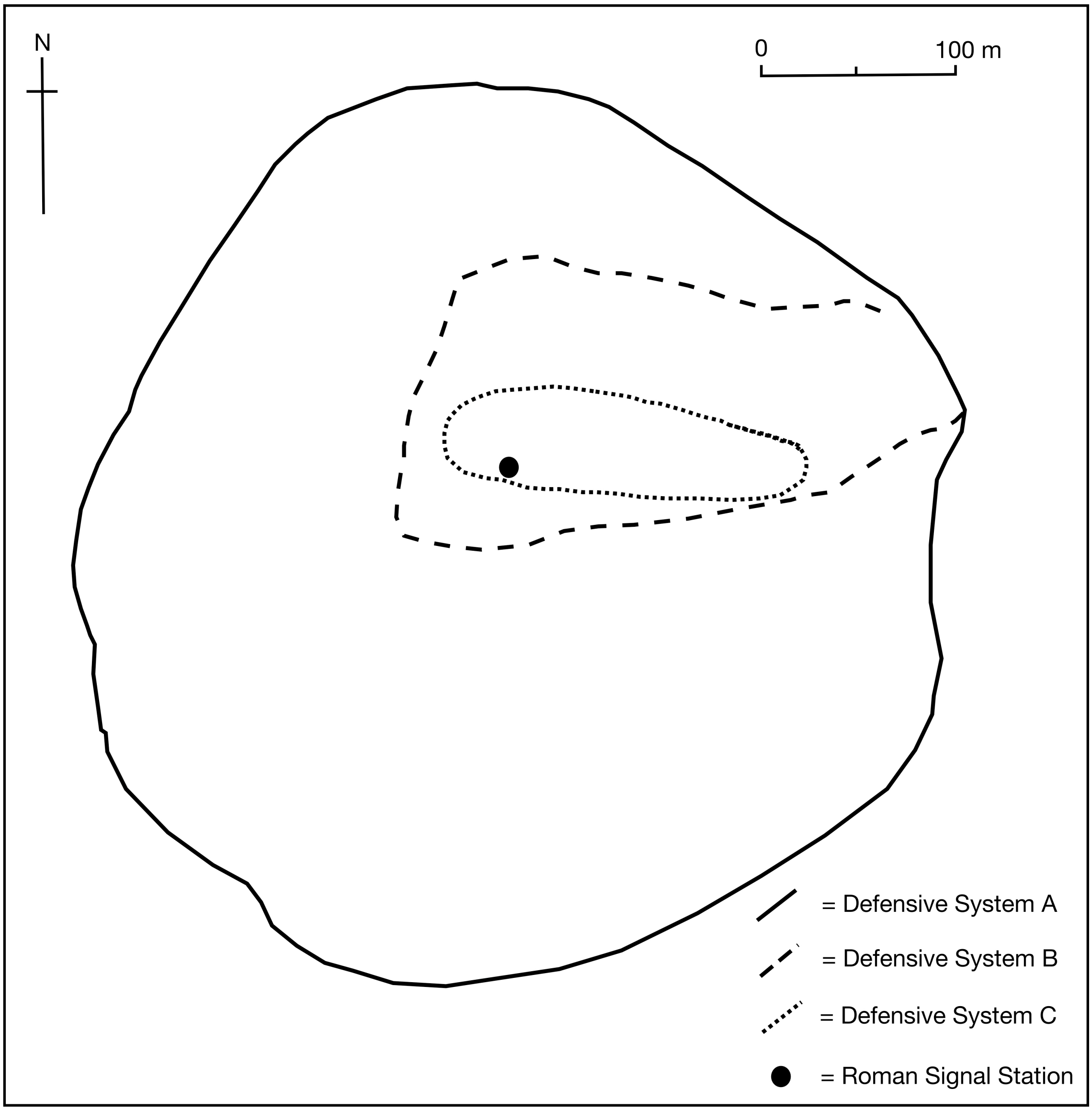

Fig. 3.10: Plan of Eildon Hill North's defensive systems.

the immanence of the emperor are all relevant features. What scope is there in the 'native' structures for promoting such complex, culturally mediated, concepts?

Considering hillforts: the choice of location, as with Hadrian's Wall was very important. Many hillforts were placed in visually prominent positions, with the characteristic ramparts occurring right across the landscape.[207] Whilst this could be interpreted as a functional consideration, prominent locations also tend to be more defensive, this was not the case upon closer examination of Eildon Hill North's anatomy. This hillfort had multiple 'defensive systems': system A

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[207] Rideout *et al.*, 1992, 23, 25, 141. Eildon Hill North is the specific example chosen here.

comprised of triple turf ramparts[208] *c*.1.6 km in circumference enclosing some 160,000 m^2 of the hill top, as shown on Figure 3.10. These ramparts, despite their size and scale, were accentuations of the local topography. The 'insubstantial nature' of this 'defensive system' meant that they may have been a territorial marker rather than a defensive line.[209] Indeed, the exploitation of natural topography would have accentuated the structure, making it appear more impressive to outsiders.[210] This lack of defensibility is further emphasised by the size of the circuit involved, it would be very difficult to levy enough manpower to effectively defend the whole circuit.[211] Similarly, the rampart of Plain Furness hillfort has been described as 'utterly inadequate' for defence.[212] This creates another parallel with the impracticality of defending the length of Hadrian's Wall. The Wall has an average of some 70 men per kilometre,[213] calculated from full strength forts and milecastles right along the line of the Wall. The Tungrian Strength Report from the Vindolanda tablets shows that under strength units may have been the norm.[214] If this report was typical for Roman military units in general, there may have been as few as 30 men per kilometre. Like Hadrian's Wall, the prime motivator behind the ramparts of Plain Furness and Eildon Hill North was not defence.[215]

Importantly, the symbolism demonstrated by the hillforts, as with Hadrian's Wall, goes beyond mere visual impact. A close association with water and fecund land could have symbolically demonstrated control over fertility, resources and possession of

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[208] Turf materials form a key part of the Wall, originally west of the Irthing and right across the Wall's length in the Vallum. This use of the natural world is important when considering the 'message' of the materials.

[209] Rideout *et al.*, 1992, 68.

[210] Rideout *et al.*, 1992, 141.

[211] Rideout *et al.*, 1992, 141. Given this factor, the classification and nomenclature of the ramparts as 'Defensive System X' can be brought into doubt.

[212] Higham, 1989, 160.

[213] Dobson, 1986, 7.

[214] Bowman, 1994, 23. The unit in question was only 1/3 paper strength.

[215] This is also the case for the city walls of many Roman provincial settlements, Thomas, 2007, 110-1.

prosperity.[216] This finds parallel on the Wall, though the Wall's method of supply could affect this symbolic message. Whilst the Wall regularly took visually prominent routes across the landscape, it also sought to monopolise land with high 'carrying capacity'.[217] It will be argued that the exploitation of such land, rather than the wholesale import of supplies, could be very important in terms of the reception and compatibility of the symbolic message of the Wall with similar displays on Iron Age hillforts.

The large labour requirement of constructing the ramparts at Eildon Hill North[218] would have reified control of labour and people. The hillforts north of the Tees show considerable input into their defences.[219] The use of local topography here underscores the symbolic message of control over the landscape, rather than simply being a labour saving measure.[220] This facet again finds direct parallel on Hadrian's Wall: the work rate expended on the Vallum could have arguably been better spent, if pure defensive function was key, in the excavation of multiple ditch systems. The ditch to the north of the Wall, for example, is one of the least workrate intensive features of Hadrian's Wall.[221] Clearly the Vallum, as with Eildon Hill North's ramparts, includes a symbolic emphasis rather than being solely concerned with pure function.

The common materials used in the construction between the Wall and hillfort are not just convenient but stamp the structure's authority and legitimacy upon the landscape. Rideout *et al.* are functional in their analysis of hillforts: 'The impression is one of exploitation of whatever materials were at hand to form the earth and stone bank […] this, combined with a deliberate effort to exploit the underlying topography wherever possible, would have reduced

[216] Dunwell, 1999, 345; Rideout *et al.*, 1992, 23, 25, 141.
[217] Higham, 1989, 165-6; *id.*, 1991, 96.
[218] Rideout *et al.*, 1992, 68.
[219] Higham, 1989, 158-9.
[220] Evans, 1988, 92.
[221] See §6.8, Table 6.23 and Fig. 6.11.

the amount of construction work required [...]'.[222] Undoubtedly workrate considerations would have had some bearing on the structures, but these were not the only factors. Dunwell sees 'a variety of non-defensive, social factors'[223] as being important to site placement and form. The importance of materials derived from the natural world, and the reworking of a 'natural' order of the landscape,[224] cannot be underestimated. This factor may have influenced the builders of Eildon Hill North's ramparts to use pre-existing topographic features, not the solely functional consideration of labour and completion time. Such considerations are compatible with Hadrian's Wall where the origin of materials, the Vallum and turf wall's locally sourced turves, combined with supply from outside the province of food and/or building materials entwine with the use of imposing topography to promote a multi-faceted symbolic whole.

This topographic manipulation goes beyond simply capitalising on the most visible land. It could emphasise legitimacy by connecting to the landscape's past. Archaeological examples of this process can be seen in the brochs and wheelhouses built on chambered tombs which appropriated ancestral power.[225] Socially mediated landscapes mean that such sacred spaces, be they of ancestral and/or religious power, may have been widespread though with few, if any archaeological identifiers.[226] Consequently, it is possible to interpret the potential Roman signal station on Eildon Hill North, usually functionally connected with the fort at Newstead,[227] as capitalising on the site's probable status as an historic political centre.[228] The process of realigning the physical and mental landscape indicates an underlying method of appropriating the

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[222] Rideout *et al.*, 1992, 64.
[223] Dunwell, 1999, 345. For social factors and a critique of solely defensive ramparts see Collis, 1996, 88-90.
[224] Evans, 1988, 93.
[225] Sharples & Parker-Pearson, 1997, 264; Hingley, 1995, 188. See also Hingley, 1996 for the use of ancestors and structures in the creation of contemporary identity.
[226] See Bradley, 2000.
[227] Rideout *et al.*, 1992, 25, 69-70.
[228] Rideout *et al.*, 1992, 66.

landscape within which the *habitus* and *praxis* took place. Importantly, these examples suggest that the emphasis placed on connexions to past power would have been easily comprehended by Roman and 'native' alike. Indeed, these forms of ancestral connexions are compatible with Roman symbolic behaviour, the importance of *mos maiorum* and the practice of *interpretatio Romano* demonstrate the scope for such links.[229]

The act of enclosure can be applied to both hillfort ramparts and the Vallum. Enclosure played a central role in the archaeology of both Roman and 'native' structures, it is important to understand the effect this act had, and what it can tell us. It was undoubtedly powerful as it formalised social order within the bounded space.[230] Importantly, enclosed structures, such as hillforts and forts, became representative of the 'core set of beliefs' of the builders.[231] There is thus the clear implication for the symbolically charged nature of bounded spaces. Furthermore, this social order, whilst being reinforced for those within the boundaries and those passing through, was also made prominent to people outside in a similar manner to the curtain wall and its Roman civic forebear.[232]

An interesting dichotomy between the hillforts and the Wall is the nature of the bounding. Hadrian's Wall is enclosed with ditches and the Vallum, the result of which is the redefinition of space without a loss of focus on the key facets themselves, the curtain Wall,[233]

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[229] Dench, 2005, 138: 'In the Mediterranean world, on the other hand, it is extremely common to use notions of ancestral kin as a loop to draw peoples in, rather than a fence to keep peoples out.' Webster, 1995, links *interpretatio* to discrepant power relations and attempts to leverage the Classical pantheon, rather than being open and accepting of 'native' gods.

[230] Ferrell, 1997, 233.

[231] Rapoport, 1976, 20-3; Evans, 1988, 86-8. Thomas, 2007, 90, highlights potential conflicts when one group is asked to build according to another's core values, in this case Greeks building Roman structures.

[232] Supra, §3.4.1.

[233] Evoking city walls, their importance as identifiers of civic and Roman identity and their connexion to the emperor through largesse.

gateways and interval structures.[234] It is best described as an underlining of the symbolic message of Hadrian's Wall, and one that would not be misinterpreted by those with a similar cultural vocabulary.[235] Just as Hadrian's Wall symbolised a unified version of Roman values,[236] so too did the 'native' settlements embody themselves and project this identity outwards.[237] In this interpretation the social order on the 'inside' and its recognition as a unified whole by those on the 'outside' was the key message, with the structures, materials and methods of enclosure selected to emphasise certain symbolic aspects of the society.[238]

An interesting facet of the act of enclosure is the repeated nature of this within one site. As noted, Eildon Hill North has multiple 'defensive systems' constructed throughout the life of the site at great labour expenditure.[239] This action, rather than being connected to utilitarian functional principles of making a site more defensible,[240] demonstrate that the physical act of construction itself was highly symbolically charged.[241] The power of this act has been discussed for Roman structures and once again a correlation can be seen between Roman and 'native'. This power was created on the Wall during its construction and maintained by its continued

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[234] The key part to the Wall's structure, subjecting those that cross through the line of the Wall to all the associated religious and ritual aspects, subordinating them to Rome's control and gaining both a fiscal and symbolic advantage.

[235] Rome's success is aligned by Terrenato, 1998, 25-6, to their flexible strategies in dealing with diverse peoples and cultural compatibility between Roman and 'native'.

[236] These values were relevant to the age of Hadrian, with certain aspects selected and emphasised as a form of propaganda. This also served as a demonstration of power doubtless necessary for control of the province. The symbolic presence of Roman soldiery, and the knowledge of their capabilities, may have been enough of a threat to ensure control. Luttwak, 1976, 195-200; Breeze, 1985, 223; Mattern, 1999, 22, 108.

[237] Ferrell, 1997, 234. Or at least the appearance of unity. Evans, 1988, 88, argues that a society expressing itself in such an overly monumental manner is indicative of one trying to arrest some form of social fragmentation. It is likely that both readings are correct, in different places and at different times.

[238] This relies on a given society to have attached some meaning to those aspects. As noted, supra, take-up of coinage and pottery relies on some need or framework within which these examples of material culture can operate.

[239] Rideout *et al.*, 1992, 27-33 for multiple defensive systems; *Ibid*., 68 for labour costs.

[240] Supra.

[241] Evans, 1988, 89, 93.

manning and later reconstructions. In this respect the low number of soldiers per kilometre is irrelevant as their mere presence is all that was required to maintain symbolic power. In a similar vein, the maintenance of an enclosure, or the repeated rebuilding or re-enclosing of a site, maintains this symbolic power for 'native' structures. Brochs, round- and wheelhouses would all have had to be maintained: roofing, repairs of both timber and stonework and fittings would all act to reinforce this symbolism.[242] Indeed, the act of construction may have been as important as the resulting structure,[243] this demonstrates commonality between Roman and 'native' structures on a symbolic level.

Despite the existence of enclosures and boundaries, these were not un-crossable lines designed to seal off the inhabitants from the outside world. Ditched enclosures had places to cross, hillforts, brochs and souterrains had entrances: in short, the act of enclosure may speak of unity and identity, but the interaction and engagement with the site and people within it, *praxis*, are key facets to understanding what these structures meant and how they worked. Once more, further parallels can be seen with the Wall: despite the militarily orientated nature of Wall studies[244] the structure itself is provided with multiple crossing places enabling north/south movement. Vallum and ditch crossings allow access to the interval structures, the forts and milecastles, and occurred with rigid regularity thus providing ways to traverse the Wall itself.

Do Iron Age structures show a similar emphasis on crossing that would correspond to the Wall's? Souterrains, shown on Figure 3.11, were underground structures which occurred right across lowland Scotland.[245] They were noted for their thresholds, which could be of

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[242] Armit, 1997b, 250. This is also connected into enforcing the unity of the household identity, and combines well with the idea of 'corporate identity' discussed in Ferrell, 1997, 234.

[243] Evans, 1988, 89.

[244] See §2.3-4.

[245] See Barclay, 1980; Watkins, 1980; Armit, 1999. See Watkins, 1979-80, 201, Fig. 13 for distribution of souterrains in Angus and Perthshire.

Fig. 3.11: Excavated souterrain at Ardestie, near Dundee.

variable width and height. Whilst they were often high enough to allow an adult to pass freely,[246] they could also be low and cramped.[247] This would not affect the ability for an able bodied adult to pass through the threshold, but it would highlight the act of passage itself.[248] This is further reinforced by Redcastle souterrain's sharp step,[249] though these structures may not possess the overly monumental character of their Roman counterparts on the Wall, they still possess the same emphasis on the act of boundary crossing, though not traversal as they had only one way in. Importantly, souterrains appear to be a more or less standard structure in many settlements, thus comprehension of this facet on Hadrian's Wall could be widespread.

Souterrains in general, not just their entrances, would have been highly symbolically charged. Whilst identified with food storage, this may not have been a solely functional consideration. Similarly, not

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[246] Armit, 1999, 581. Entrances can vary between 1.2m and 3.6m.

[247] Armit, 1999, 581.

[248] Someone with a physical disability would perhaps not view the structure in such a welcoming manner. This serves to highlight how discrepant readings of a structure within the same culture can occur; the scope for this would be greatly increased when one moves outside of their culture and contends with a different *habitus*.

[249] Alexander, 1998, cited in Armit, 1999, 582.

all souterrains may have been used solely for this role.[250] There is a ritual significance to food storage,[251] and an express connexion between their use for grain and ritual can be suggested.[252] Their functional connexion to food would have made them potent signs of surplus and fertility.[253] This was commensurate with the way hillforts demonstrated their connexion to fertility and water; souterrains, though, do not do this through association with relevant parts of the landscape, but through its produce. Once again, the question of how the Wall is supplied is important for the reception of the structure. Without any local level supply this important symbolic association may well have been lost.[254]

Similarly, their stone-built nature connects to the symbolic power associated with this material. The labour intensive nature of the structure demonstrates control over the people needed to quarry and transport the stone, and access to the required expertise to build effectively.[255] This would have only been available to a few members of the communities, and would thus be a potent symbolic display of power.[256] Furthermore, the ongoing use of the structures in their day-to-day storage role would have meant their continued symbolic power through *praxis*. Souterrains may not just have been built of stone. Turf built souterrains, whilst less archaeologically identifiable, would have added a further dimension to the symbolic strength by being, perhaps, further widespread and incorporating turf based 'material rhetoric'.

Brochs, see Figure 3.12, are the last group of structure to be examined. Whilst souterrains have been referred to as

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[250] The structures' variability lead Barclay, 1980, 206, to conclude that there may have been multiple functions.

[251] Hingley, 1992, 29.

[252] Armit, 1999, 583. It is argued elsewhere that, contra Carl *et al.*, 2000, practice can and does reinforce ideology. Souterrains would be another such example of this taking place, where their function is in part connected to their symbolic power.

[253] Armit, 1999, 583.

[254] See §9.4.

[255] Armit, 1999, 583.

[256] Sharples & Parker-Pearson, 1997, 264; Armit, 1999, 593.

Fig. 3.12: Broch Mousa on Shetland. Monumental exterior, left; interior, right.

'monumental'[257] brochs are closer to the Roman concept of the term. Enclosure, its recurrence here underlining the importance of the act, can be seen in the large, impressive stone-built broch walls.[258] Once again, they would have demonstrated power, the ability to control labour and surplus, the close association with water as well as access to both materials and specialists.[259] Again, the material of the walls would have imbued the structure with symbolic power in much the same way as the other structures analysed and their Roman counterparts. A key difference between these structures and the Wall is the type of movement they control. Hadrian's Wall controls movement through the structure, whereas the brochs, souterrains, hillforts, wheel- and roundhouses all control movement into the structure. This provides the Wall with an element of coercion, and symbolic force, as it cannot be avoided in the same way a static structure can. The sealing of the isthmus, rather than being a defensive decision, provides this and renders the Wall as a landscape in its own right, open to the same mediation and playing the same role in cultural formation as the area it surveys and the more traditional inter-connected settlements of the Roman empire.[260]

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[257] Armit, 1999, 583.

[258] Sharples & Parker-Pearson, 1997, 264, conclude that Broch walls were related to exclusion rather than the inclusiveness and unity of the 'corporate identity' outlined by Ferrell, 1997, 234.

[259] Macinnes, 1984, 240; Sharples & Parker-Pearson, 1997, 264. Armit, 1997b, 249-50, discusses this facet with regard to Atlantic roundhouses, specifically their 'outward projection of monumentality.'

[260] Hingley, 2005, 108-9.

The monumentality of the structure is a key feature, despite their seemingly atypical form, it can be argued that the internal ordering and not the external appearance is the important part of the structure.[261] Indeed, external variability can be taken as a display of separate identity. The connexion between brochs and wheel- and roundhouses, and the chambered tombs that they were sometimes built over[262] becomes more explicit. This link to previous authority and legitimacy allowed architectural elaboration. The monumentalism of brochs became a new way of displaying status without risking the widespread comprehension of their legitimacy. Once more, the possible Roman station on Eildon Hill North can be seen to be connected to this tradition and show that Roman and 'native' understandings of the landscape were not necessarily divergent and that, at the very least, Rome knew how to interpret Iron Age landscapes.

As with the other structures, brochs possess an access way for traversing their boundedness. Once again a symbolic advantage can be seen in passing through, and into, an area unified and solidified by the external walls. This passage itself was marked by having to bow low to enter,[263] in effect, a submission to the structure's ordering of space similar to that seen in milecastles by passing under the symbolic and religiously charged archway into the re-ordered domestic space of the interior. Interestingly, repeated throughout almost all brochs are the 'guard chambers' which can be found on either side of the entrance.[264] These were undoubtedly important given their repetition and form a direct parallel for passing through Roman fort gateways as these were flanked by guard-towers. This provides an interesting, if potentially unintentional,

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[261] Macinnes, 1984, 238-9. This can once again be tied into the boundary simply being that which 'declares' the identity and social order within to be unified. See Ferrell, 1997, 234.

[262] Sharples & Parker-Pearson, 1997, 264, for brochs; Armit, 1997b, 252, for round- and wheelhouses.

[263] Sharples & Parker-Pearson, 1997, 264.

[264] Sharples & Parker-Pearson, 1997, 264.

opportunity for comprehension of similar spatial layouts and identities between Roman and 'native'.

§ 3.6 | Conclusion

This chapter began by highlighting the weaknesses of purely functional interpretations of the Wall. By relying on modern understandings of frontier structures such analyses say more about the Wall's meaning in the modern world than at the time of its construction.[265] In order to understand the Wall's role and significance in the Roman-era a far broader contextual analysis has taken place. This concentrated on the symbolic power of monumental Roman structures, a power intimately connected to disparate factors such as the cost of construction, the materials from which it was built as well as religious and imperial associations. This thesis argues that the best way to consider the power of the cost of construction is by way of a full quantitative survey, that embraces materials, labour and supply.

The connexion between the Wall and *maiestas* has been rendered explicit, the structure's primary goal was to enhance the state's perception through both visual prominence and day-to-day use. However, the use by the Romans *maiestas* to mediate status means there is far greater role for the Wall in social formation. This role encompasses aspects such as economic stimulus and participation, both voluntary and forced. In this interpretation the Roman military, so often seen as a cause of economic stagnation in Britain, was not intended to hamper the development of an economic substructure to the north of the province. Such an economic realignment affected both high-status individuals, who could participate through their patronage of Roman goods, and non-elites who had their *habitus* and landscape altered along Roman lines.

[265] See Donaldson, 1986, for machine-gun parallel.

Hadrian's Wall enshrined both the visual and the practical: it was not 'merely' rhetoric[266] as its monumental presence significantly altered the landscape. Its multiple functions were not the reason for its existence, these actions were connected to the mediation of status as an end-point beyond the mere effective running of the Wall. This symbolic power was maintained by the stationing of the comparatively few Roman soldiers on the Wall, where their visibility and the Wall's functioning reinforced the structure's power and connected the state and structure's *maiestas* to that of the person. Consequently, an active role in social formation can be applied to both the Wall and its military constructors. Analysis of such a role in the past has varied between the Roman maintenance of power through bloody and repeated acts of violence[267] through to voluntary 'self-Romanisation' once the benefits of the Roman state are made evident.[268] The creation of a Roman-centric space through a combination of *maiestas* and landscape manipulation is not a sanitised version of how Rome extended her power, but rather it relies on discrepant experiences and power imbalances. The close alignment between victory monuments and the Wall meant that the threat of violence, both symbolic and actual, was never far away. The right to set the cultural agenda, whilst an intrinsic part of becoming Roman, meant that monumental architecture and the landscape both formed a canvas of potential conflict, leading to discrepant experience.

The Wall itself was built around the idea of its use, hence the importance of milecastles for passing through the Wall. That symbolism was a key factor can be seen both in the existence of the Vallum, whose labour could have been spent on the more usual multiple ditch systems to the north and south of the Wall, and the careful selection of the structure's anatomy. With the curtain being

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[266] Contra Mann, 1990, 53-4.

[267] Mattern, 1999, 103.

[268] Luttwak, 1976, 78, 88. Mattingly, 2006, draws a parallel between the teaching of the British Empire as a largely benevolent 'civilising' force and its transposition onto the Roman world.

connected to civic aspects of Rome, promoting ideas of a unified social order on the inside, and the recurrent interval structures forming parts of a symbolic whole, the result was a structure that had the same symbolic impact regardless of where it was encountered. That these structures took the symbolic message from the peaks of the Whin Sill to the estuary of the Solway was further testament to the importance of effort and labour.

This reception of the Wall was all important, specifically the idea of similarities and differences in the Roman demonstration of *maiestas* and similar power and status displays in 'native' society. Not only does the Wall's form imply plurality, with multiple ways of altering the visual and mental landscape along Roman-centric lines, but its reception allows for similarly discrepant responses. This plurality in responses to Rome is fundamental for understanding both the Wall's existence and form. Whilst the potential for comprehension of many Roman 'values' is demonstrated, the wider fragmented 'native' society may have accepted and displayed Roman cultural indicators in distinctly un-Roman ways, or have outright rejected them. At its core, the reason behind the Wall's existence, to promote a new Roman-centric culture by whatever means, was connected to a desire to expand Roman power and create a province identifiably Roman through their cultural indicators. This is in stark contrast to many interpretations of the Wall which seek to define the structure as a defensive boundary of empire, an idea which was anathema to both the role of the emperor and the concept of the Roman state's *imperium sine fine*.

IV | Methodology

> ***For it is not every neighbourhood or particular locality that can have a wall built of burnt brick like that at Babylon, and yet possibly each may be provided with materials of equal usefulness so that out of them a faultless wall may be built to last forever.***
>
> VITRUVIUS, *DE ARCHITECTURA*, I.V.8

§ 4.1 | Introduction

In this reassessment of the Wall, emphasis has been placed upon meaning in the landscape. Hadrian's Wall, as has been discussed, can be seen to have caused a 'semiotic disturbance'[1] in the pre-existing landscape deeply affecting its reading and interpretation. Given the scale of work required, the need to quantify the material and labour cost can be seen as vital to understanding the symbolic impact of Hadrian's Wall. Traditionally, quantitative survey has been used to answer functional, rather than theoretical questions. However, this thesis has stressed the Roman emphasis on effort as part of the symbolic power of a structure, thus quantitative survey is here applied to theoretical questions aimed at understanding the Wall's symbolic force. Furthermore, the quantitative process can also be applied to testing pre-existing models, allowing assessments of Woolliscroft's signalling theory and other functionalist interpretations.

At its core, a quantitative survey is the measurement of structures to determine how much materials and labour cost would have been required for completion. The broad methodology of quantitative survey involves the measurement of structures and the volume of their materials. From here, the amount of work required to complete

[1] Boyle, 2003, 31-2.

the structure is estimated. This includes such aspects as the working of materials, shaping, mortaring, lifting and haulage. The final stage is the costing, with values for labour per person day, equipment, scaffold and materials cost resulting in a fiscal value placed on the structure.

Clearly, this leaves the methodology open to issues of accuracy and precision as much of the structure being surveyed is conjectural. An unavoidable consequence of quantification is a false impression of precision, seen in the multiple decimal places that can be generated. Whilst imprecision is avoidable, inaccuracy is not as these calculations are only as accurate as the conjecture placed upon the structures. Consequently, this study places an emphasis on the clarity and transparency of the conjectures on which it is based. The model itself is flexible in that, should any one of the variables be altered, the quantitative results are changed in line. This is a key difference between this thesis and earlier studies,[2] which allows inferences to be clearly seen and followed, aiding the integrity of the conclusions.

The preservation of both Caracalla's Baths[3] and Inchtuthil[4] allows their surveys to be presented with a degree of solidity that cannot be applied to the Wall. Furthermore, these structures are comparatively small scale and built from a limited range of materials. In comparison, the Wall's scale is in significant contrast to these two earlier studies and it was built from a bricolage of materials.[5] A complex methodology for calculating both materials and labour is summarised in Figure 4.1, which shows a flow chart of the

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[2] See §1.3.

[3] Delaine, 1997.

[4] Shirley, 2000.

[5] As mentioned in the epigraph, a variety of materials can be used to form a wall. De ipso autem muro, e qua materia struatur aut perficiatur, ideo non est praefiniendum, quod in omnibis locis, quas optamas copias eas non possumus habere. Sed ubi sunt saxa quadrata sive silex seu caementum aut coctus later sive crudus, his erit utendum. Non enim, uti Babylone abundantes liquido bitumine pro calce et harena ex cocto latere factum habent murum, sic item possunt omnes regiones seu locorum proprietates havere tantas eiusdem generis utilitas, uti ex his comparationibus ad aeternitatem perfectus habeatur sine vitio murus. Trans., Morgan, 1914.

processes used per structure to calculate the total cost. The black lines show processes requiring equations, such as using the structural model to estimate volumes; the grey dotted lines represent addition, such as a total material estimate being the sum of the materials within the structure. Each process is discussed in their relevant sections to which this chart forms a reference point.

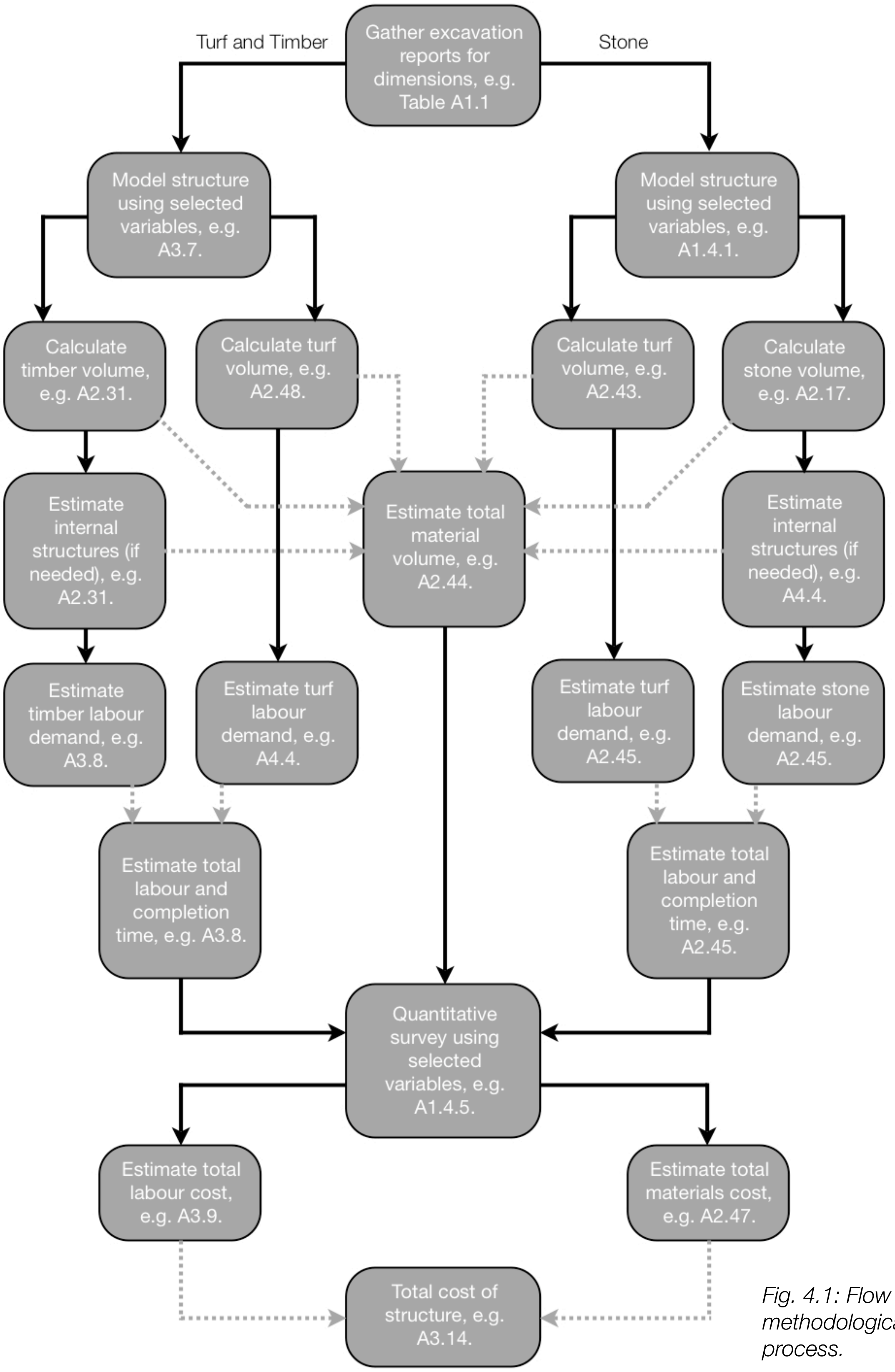

Fig. 4.1: Flow chart of methodological process.

§ 4.2 | Data Collection

Primary data collection is through published reports. Excavation has been ongoing along the Wall since the 19th century to varying standards. Consequently, many of the sites were excavated before urban-sprawl claimed their places. Whilst this means some excavation has taken place on now lost sites, the antiquarian excavations are poor by modern standards. Consequently, the most complete reports are used where ever possible. Many of the published reports can be found in the *Transactions of the Cumberland and Westmorland Antiquarian and Archaeological Society* and the Society of Antiquaries of Newcastle upon Tyne journal, *Archaeologia Aeliana*. Furthermore, publications such as Eric Birley's *Research on Hadrian's Wall*[6] and J. Collingwood Bruce's *Handbook to the Roman Wall*[7] provide detailed guides to the excavations and relevant works for Hadrian's Wall.

In some cases the excavations have not been published in detail. In this instance, unpublished reports and grey literature as well as field investigation[8] were used to gather the dimensions of the structures in question. This is noted in each chapter's relevant appendix, where a table is included showing the data source. This allows the estimations of volume and work-rate to be compiled for structures without detailed published excavation, providing as near to complete coverage of the Wall and ancillary structures as possible.

§ 4.3 | Errors and Erroneous Data

As will become clear from the ensuing methodology, the need for accurate data is of paramount importance. This, juxtaposed with the nature of excavation reports which are at times in excess of a century old, can cause problems. Firstly, the conversion between

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[6] Birley, 1961.

[7] Currently in its 14th edition, Breeze, 2006b.

[8] This was carried out with the permission of site owners and involved measurement of the structure's walls. Internal buildings, being mathematically modelled, did not need measurement.

metric and imperial figures instantly creates an error margin through rounding. The outcome of such conversions will be rounded to two significant figures as sub-millimetre accuracy is spurious in quantitative calculation. The second consideration is the nature of the reports themselves, antiquarian-era reports often do not mention in their text the technical information required for this study. Consequently, scaling from diagrams is required which is, naturally, open to errors. As a consequence of these issues, an appendix detailing data that have been scaled from diagrams, or assumptions made, is included in the appendices for each structure. Whilst the scale of the undertaking may provide room for errors to be compounded, it also provides the means for these to balance out over the course of the study,[9] this would only present itself as a major issue should the sample group be small. This is the key reason behind the decision to always assume the lowest figure in cases of doubt.[10] This minimal assumption means that errors are kept to a lower order of magnitude.

The issue of figure rounding is of clear importance.[11] The presence of figures to multiple decimal places is the unavoidable result of the quantitative process and, whilst this represents great precision, should not intimate high levels of accuracy.[12] By not rounding, the chance of calculating from compound errors is reduced and mathematical distortion kept to a minimum. The process of rounding will, therefore, take place at the conclusion of calculation, thus removing the image of false accuracy portrayed by multiple decimal places in the outcome. However, for transparency, the non-

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[9] Faulkner, 1998, 36, 41-2.

[10] Infra.

[11] For more on this with regard to weights and measures see §9.3.3, Stolle, 1914; Roth, 1999, 4.

[12] Faulkner, 1998, attempts to avoid such problems by the creation of 'construction units'. These were generated by taking the fiscal value of the quantitative survey and dividing by ten, then rounding. This removed the image of false accuracy as well as the often contentious use of a modern currency figure. It is also noteworthy that Faulkner stresses that a structure assessed in modern terms as requiring 25 times more labour than another, would have possessed the same order of magnitude in antiquity, *Ibid*., 38.

rounded figure will always be referenced in footnotes. Finally, as noted, where there is ambiguity between two figures, the smaller figure is selected, minimising errors and allowing for simple percentile inflation if needed.

§ 4.4 | Stone Volume Calculations

With the exception of Bewcastle's hexagonal form, all the structures in the sample group are rectilinear in shape. This allows the volume of each wall to be calculated independently of the others; the results are then totalled to provide an overall volume for the building. This presents a more nuanced understanding of the structure as not all walls were the same size. The turrets on the eastern half of the Wall, for example, were recessed into the curtain and thus had a markedly thicker north wall than the other three sides. This division of walls into separate calculations allows their individual characteristics to be considered, Hill uses an average of east, south and west walls in his study of the Wall's turrets.[13] Whilst useful when one or more walls are missing, this methodology does not provide enough subtlety for an in-depth quantitative survey of a structure with a complete ground plan.

Splitting the walls of a rectilinear structure into separate structures avoids the calculation of each corner twice. Figure 4.2 shows that the side walls running north-south are measured externally, whereas the north and south walls are measured internally. This gives the length and width dimensions required for part of the volume calculation.[14] It must be noted that the length value of walls on larger structures will have the length of any interval buildings, turrets in forts for example, removed as these will be calculated separately and added onto the total. This prevents the repeated calculation of these values. The simple formula for calculating volume is:

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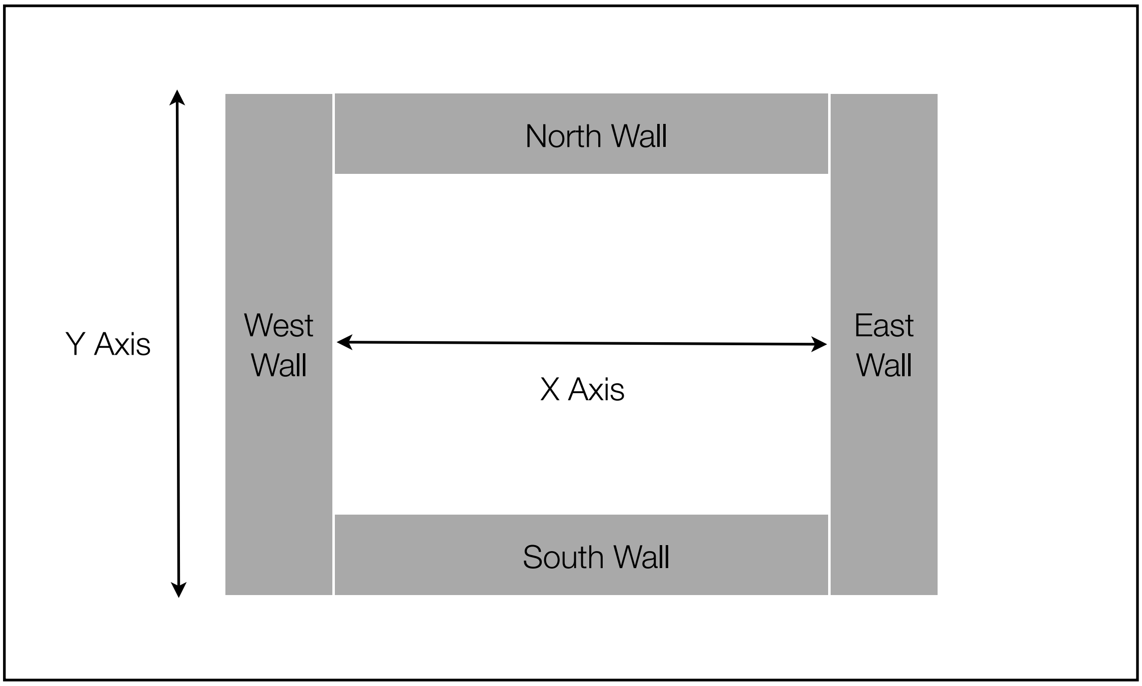
[13] Hill, 1997, Table 1, 44. T18b's south and east walls, for example, are different from its west wall.

[14] Bewcastle is measured through splitting the walls into six individual units of variable length before quantification.



Length x Height x Width

Fig. 4.2: Division of a rectilinear structure for separate calculation.

The height value introduces the issues of multiple offsets and the foundation layer of a typical Roman wall. There was not one specific type of wall built, their form varied according to which unit was performing the construction and the available materials. The different parts of the anatomy of a wall built by Romans can be seen in Figure 4.3. Importantly, any wall may possess some, though not necessarily all, of these features: west of the Irthing, for example, foundations of cobbles or puddled clay are relatively common, in the east less so. This can be compounded by a lack of survival of all these features, and also their sporadic recording. Consequently, the superstructure width is assumed for the total wall.[15] Given that most of a wall would be comprised of the superstructure, and that at most an offset would be 20cm high and 2-5cm wider than the superstructure, there is minimal effect caused by this decision and it importantly allows the application of the same rules to all structures. The exception to this is in calculating the curtain wall, whose great length means that the extra size occurs across hundreds of kilometres. As can be seen in A2.2, this includes separate

[15] Where no superstructure survives, the most relevant measure is used from the excavation report. Thus offset 2 may be chosen, rather than the first offset.

superstructure and offset volumes. It is important to note that the anatomy of a Roman wall shown here does not include any crenellations, this is primarily due to the lack of evidence for the top of Hadrian's Wall.[16] Its exclusion is in line with the project methodology, above, of using minimum calculations. This calculation also includes mortar volume, thus any calculations considering the haulage of the stone automatically include the cost of moving the mortar. Specific calculations consider the effect on the labour costs of working mortar.

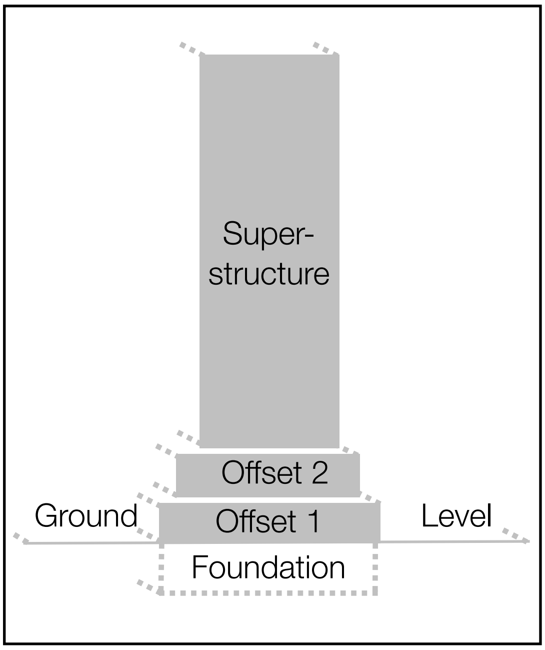


Fig. 4.3: Section of a Roman wall. Not to scale.

There is, however, more to volumetric calculations than the four walls of a rectilinear structure. Forts and milecastles have archways for access and egress and turrets have doors, both of which reduce the amount of stone required as they are, effectively, holes in the walls. Firstly, the doorway is handled quite simply, the volume of the space the door would take is removed from the volume of the wall in which it is present. The following formula is used:

Wall Volume - (Doorway Length x Wall Width x Doorway Height)

The immediate question is the height of the door, given the low occurrence of vertical survival on the Wall. Hill estimates a height of six Roman feet,[17] consequently the door height is assumed to be 1.778m.[18]

Rather than using the same formula for gateways, a different method needs to be used because the gateway occupies the entire height of

[16] Breeze, 2006b, 110.

[17] Hill, 1997, 34-5. For more on door and window design see Hill & Dobson, 1992, 39.

[18] Hill, 1997, 35. Hill states that 6Rft/5'10" equates to 1,880 mm; however, 6Rft/5'10" actually equates to 1,778 mm.

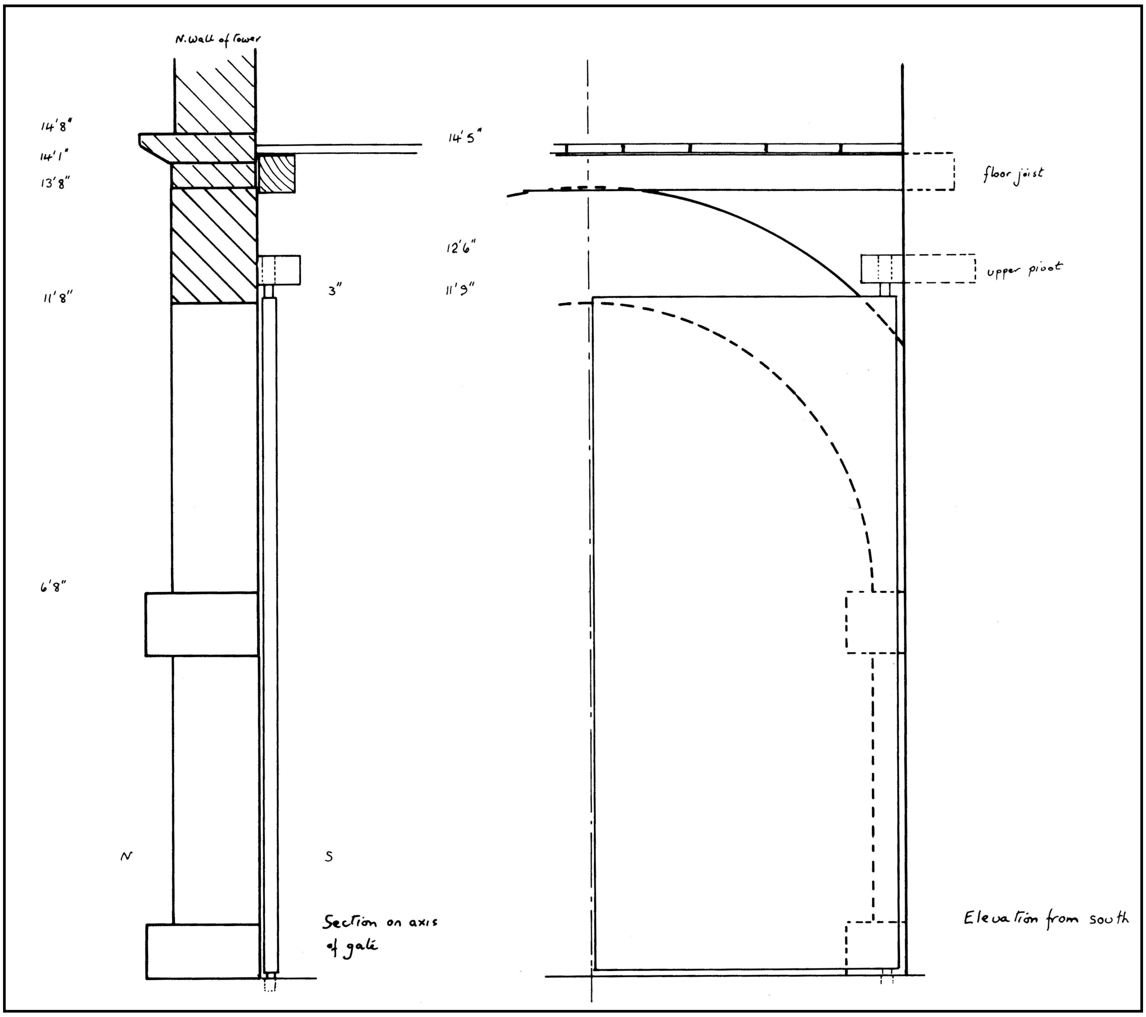


Fig. 4.4: Illustration of the anatomy of a MC gateway, with heights.

the first floor and is a non-rectilinear shape. The following process is used for the calculation of each individual portal and is summed up at the end of the section in Figure 4.5. The first step is calculating the volume of the gap in which the gateway rests, this is a simple volumetric calculation, which is then removed from the overall wall volume:

Length of Opening x Wall Width x Wall Height

Wall height, in this instance, is assumed to be 3.55m. This is due to the work on MC37's north gateway, which shows the top of the arch reaching to this height, this can be seen on Figure 4.4, and is assumed for all of the gateways on Hadrian's Wall due to a lack of other data. From this block, a cylinder representing the opening will be removed by using the following equation:

$$\pi \times (\text{Length of Opening} \div 2)^2 \times \text{Wall Width}$$

The remaining volumetric figure represents the stone around the cylinder. The gateway was open to traffic, thus the figure is halved to account for the stonework solely forming the archway. The stone between upper pivot and floor joist is calculated with this formula:

(Wall Height - 3.55) x Length of Opening x Wall Width

Finally, this figure is taken and added to that from the previous step, resulting in the total volume of the stone used in the archway. This is then added to the total volume for the wall in which the archway occurs.

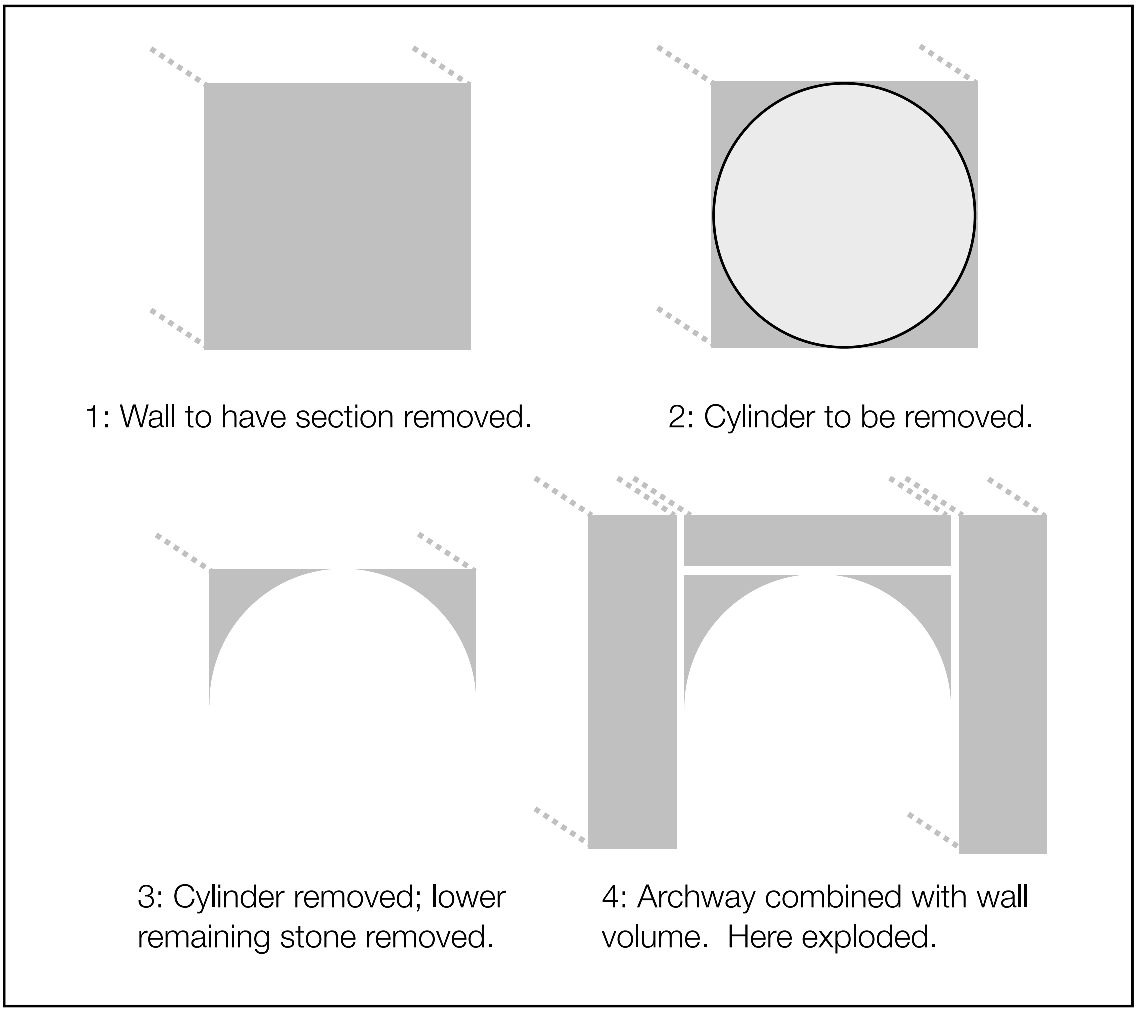


Fig. 4.5: Schematic breakdown of gateway arch calculation process.

§ 4.5 | Heights of Structures

The height value of the volumetric calculation differs depending on structure. The curtain and fort walls, as well as milecastle towers and interval turrets, each have separate values estimated from various sources not necessarily on the Wall itself. This is, naturally, a contentious subject given the lack of direct evidence. This paucity has led to a need to consider comparative data, the height of turrets, milecastle towers and the curtain wall itself will all be informed by this approach.

§ 4.5.1 | Curtain and Fort Walls

There are two keys to estimating the overall height of both turrets and milecastle towers. The first is informed by the Wall itself, notably MC37 (Bardon Mill), MC48 (Poltross Burn) and Housesteads. The survival of three steps at MC48 allowed a projection of the height of the wall to which the tower was built, coming to 3.66m.[19] Similarly, survival of steps at Housesteads allowed such measurement to take place, resulting in a height of 4.2m.[20] Finally, excavation of the north gate of MC37 revealed an estimated height of 4.37m on the basis of the height of the arch span, as the piers and impost caps survived.[21] Similarly, a structural height of 4.39m, on average, would be required in order to allow the milecastle gates to open without damaging the milecastle itself.[22]

The second piece of data is comparative, from the German fort at Wörth. Here a wall collapsed into a ditch which was subsequently filled, sealing the almost complete structure in place. This wall measured 4.5m.[23] Whilst Germany is physically some distance from Hadrian's Wall, this figure cannot be roundly discounted since the complete wall survives; none of the examples from the Wall can

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[19] Breeze, 2006b, 287.
[20] Crow, 1995, 30.
[21] Hill & Dobson, 1992, 47-9.
[22] Hill & Dobson, 1992, 46-9; Breeze & Dobson, 2000, 31.
[23] Johnson, 1983, 70.

match this. Importantly, as units come to Hadrian's Wall from all over the Roman world, the size of walls elsewhere is relevant as units' building traditions may differ from place-to-place. This is perhaps best seen on the Wall with the different milecastle gateway types indicative of different legionary building teams.[24]

Taking these varied sources into consideration, the value for the height of the curtain wall could be anywhere between 3.6m and 4.5m, the average of all these sources is c.4.2m.[25] However, the Wall itself was unlikely to be uniform across its whole length, thus caution is erred upon and a height of 4m is presumed for the curtain wall in this study. The forts, using the evidence from Housesteads, are presumed to be 4.2m; similarly the direct evidence from MC37 means that these structures have estimated wall heights of 4.37m.

§ 4.5.2 | Turrets and Towers

The estimated heights of turrets and towers is a question more complex than that of the curtain, forts and milecastles. It brings into consideration the Roman 'building module', based around permutations of 5Rft.[26] Consequently, for the Wall's turrets, comparative data will be used, based around this 'building module'. This necessitates parallel calculations around differing permutations of 10Rft or 15Rft floors. Since the data for wall heights, discussed above are all greater than 10Rft, the ground floor will always be assumed to be 15Rft, 4.4m, in height:[27] the first and second floors will thus be either both of 10Rft, both of 15Rft, or one of each

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[24] Breeze, 2006b, 67.

[25] (3.66+4.2+4.37+4.39+4.5) ÷ 5 = 4.204

[26] This is cited in several places in Hill & Dobson, 1992, 27, 37-8. Notably in discussion about the turrets. This 'building module' is assumed to be connected to the height and width of the broad wall. Hill, 1997, 35. 1Rft is equal to 29.6cm, Walthew, 1981, 15; Hill, 2004, 4.

[27] This is further corroborated by Hill & Dobson, 1992, 38; Hill, 1997, 35. It is also broadly in line with the evidence from MC37 of a wall height of 4.37m.

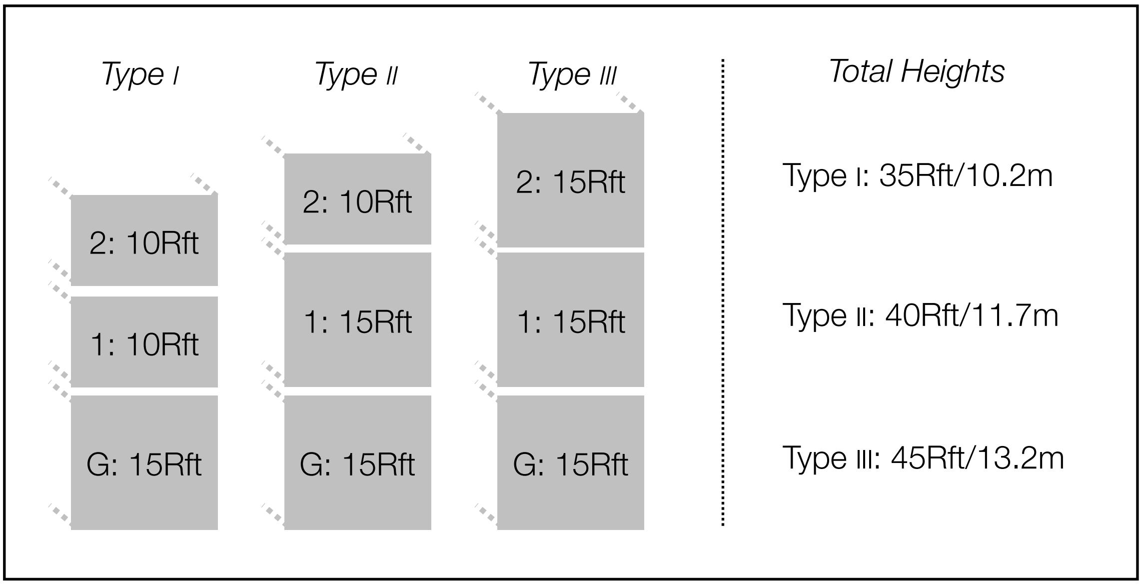

Fig. 4.6: Schematic of different sizes of turrets, and total height of each type.

height.[28] This results in three types of structure with three different total heights, and is illustrated on Figure 4.6. Similarly, the milecastle towers are presumed to have two floors and mirror the pattern of the upper floors on the turrets.

§ 4.5.3 | Turret and Tower Wall Widths

Another aspect affecting the volume of the upper walls is their width. Surviving evidence, again from the best preserved gateway on the Wall at MC37, shows that the walls of the first floor of the tower had a width of 0.45m,[29] compared to the comparatively wide ground floor gauge of 2.29m on the north wall and 2.59m on the south, east and west walls. This effect, referred to as tapering, is in contrast to a structure with the same wall width throughout all of its floors. Due

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[28] Hill & Dobson, 1992, 38 suggests a first and second floor height of 2.13m, however, given the length of a *pilum*, *c*.2m, standard equipment for legionary and auxiliary alike at this time, it is felt that this is unreasonably low, even though it would make the total height of both floors conform to the building module. Vegetius describes the *pilum*: 'The javelins that the infantry army used were called *pila*, having thin triangular heads 9" or 1' long, such as once lodged in a shield could not be broken off and when thrown skilfully and with force might easily pierce a cuirass.' Missilibus autem quibus utebatur pedestris exercitus pila vocabantur, ferro subtitli trigono parefixa unciarum novem sive pedali, quod in scuto fixum non possit abscidi et loricam scienter ac fortiter directum facile perrumpit. Veg. *Epitoma* I.20.20. The overall size of the *pilum* is mentioned later: '[…] two javelins, one of which was larger, with a triangular iron tip 9" long, and a shaft of 5½'; it used to be called a *pilum*, and is now known as a *spiculum* […]' […] item bina missibilia unum maius ferro triangulo unciarum novem, hastili pedum quinque semis, quod pilum vocabany, nunc spiculum […] *Ibid*., II15.5. Translation from Milner, 1996, 22, 47.

[29] Hill, 1997, 29.

to the direct evidence from the Wall, and the fact that tapering wall widths would provide benefits in the form of increased internal space and access,[30] all floors above the ground are presumed to have wall widths 0.45m. The floors with walls of differing widths will be separated off from one another, calculated separately in order to take account of this nuance, before being remarried to give the total volume of a structure.

§ 4.6 | Turf Volume Calculations

As mentioned in the introduction, the Wall's complexity is underlined by its use of various different materials. These can be discrete, east of the Irthing stone is the key material; or a bricolage, west of the Irthing stone towers mix with turf and timber milecastles, forts and curtain. Turf's properties mean that the simple rectilinear calculations used for stone structures are not applicable, consequently, different formulae are needed. Due to the preservation of turf and timber in the archaeological record much of this discussion is informed by modern simulations, which provide a fascinating insight into the process of Roman construction and the forms which turf and timber buildings take.

§ 4.6.1 | Turf Ramparts

Turf ramparts are, unlike their stone equivalents, trapezoidal in shape with characteristics shown on Figure 4.7.[31] As with stone calculations, the nature of the archaeological record leaves certain variables open to interpretation, notably the top width of the trapezoid and, as ever, the overall height of the rampart. Fortunately, basal width is provided by excavation and can be given with a far greater degree of confidence.

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[30] Hill, 1997, 29, 34.

[31] Jones, 1976, 79, Fig.16 gives different profiles for turf ramparts. Timber revetted ramparts tend to have a smaller basal width, *c*.3.5m compared to *c*.6m for non-revetted examples. The Turf Wall's structures conform to this latter measure, providing evidence that they were not timber revetted, Jones, 1976, 70. Clay revetment was found at Appletree, Whitworth, 1992, 52.

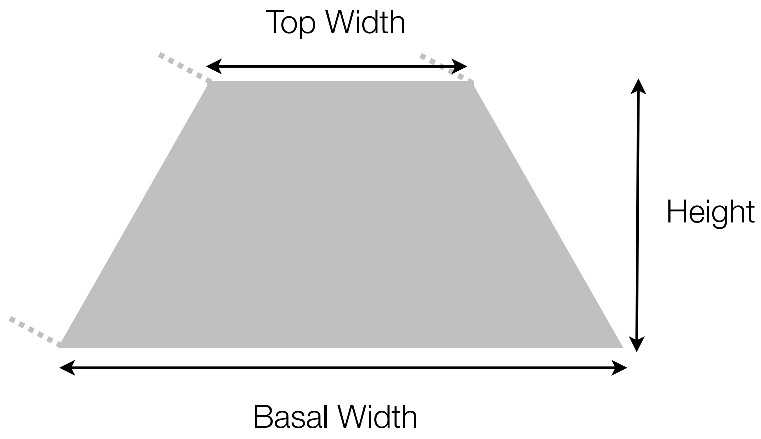

Fig. 4.7: Section through turf wall with variables. Not to scale.

Calculating volume for a trapezoidal structure requires a two stage formula. First, sectional area is calculated:

Sectional Area = ((Top Width + Basal Width) x Wall Height) ÷ 2

Then, volume is calculated with:

Volume = Sectional Area x Length of Rampart

Finally, should a foundation be present, this volume is calculated separately in the same manner as stone, above §4.4, and the total added to the volume of the trapezoidal calculation. This volumetric calculation can be applied to the ditch north of the Wall, as well as the vallum ditch to south, due to the fact that these are effectively inverted trapezoids.

To answer the 'missing' variables of a trapezoidal structure, both modern simulations and the stone counterpart are used. Considering the top width, this can be informed by the stone wall in the east: if the top width in this area was adequate, then the value may well be the same. The stone wall's superstructure width varies between 1.8m at its slimmest, and 3m at its widest point. The slimmer value is reinforced by Brian Hobley's turf simulation at the

Lunt in Bagindon: here a wall walk of 1.8m is used.[32] Both of the stone wall's values, however, will be used in order to provide comparative data and discussion. Volumetric measurements will be given for both a 1.8m wall walk, referred to as a Type I turf structure, and a 3m wall walk, referred to as a Type II turf structure. The minimum value here not only coincides with stone structures, but is also functionally acceptable, it allows two men to pass one another and conforms to Vitruvius claims that 'the thickness of the wall should, in my opinion, be such that armed men meeting on top of it may pass one another without interference.'[33]

Height is another variable in need of discussion, once more, both simulations and the stone wall can provide insight. The same figure of 4m will be used for turf ramparts to reflect continuity with the Wall in the east. Similarly, the height of the Lunt simulation is 3.7m, in line with evidence from MC48, and further reinforces the applicability of the *c*.4m figure. It must be noted that, although this figure is applied across the length of the study, the various pieces of evidence from the Wall imply variation. The consistent application of the 4m value is not intended to argue for uniformity of the Wall's height, merely to provide a reasonable variable for calculation.

Turf ramparts themselves are constructed, like the stone wall, with a central rubble core. However, rather than shaped stone, cut turves are used to flank the core. Vegetius supplies the dimensions for the

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[32] Hobley, 1967, 87.

[33] Vit., *De Arch*., 1.v.3. Crassitudinem autem muri ita faciendam censeo, uti armati homines supra obviam venientes alius alium sine inpeditione praeterire possint […]. Whilst Chapter V, entitled 'On the Foundations of Walls and the Establishment of Town', is specific to city walls, Vitruvius stresses that his advice is for 'substructures in general and all walls that require a thickness like that of a city wall', Itaque non solum in muro sed etiam in substructionibus quique parietes murali crassitudine erunt faciundi, hac ratione religati non cito vitiabuntur. This should not be taken to presuppose a wall-walk, it merely represent the influences which inform Roman structures.

standard size cut of turf:[34] 44.4 cm by 29.6 cm by 14.8 cm, a volume of $0.02m^3$.[35] One third of the structure volume is taken up with the rubble core, thus the remaining two thirds are made out of turves. Consequently, in order to calculate the total number of turves for a structure the following formula is used:

$$\text{Structure Volume} - (\text{Structure Volume} \div 3) \div \text{Volume of Turves}$$

As with their stone counterparts, in order to avoid calculating the volume of the corners twice, the structure is split into separate walls. The north and south walls' lengths are measured internally, and the east and west walls' lengths are measured over the ramparts, as seen in Figure 4.1.

§ 4.6.2 | Rampart Backing

Not all turf structures were trapezoidal in shape and those that were not require a different approach. The rampart backing, illustrated in Figure 4.8, is most commonly found in the stone forts of Hadrian's Wall and is fundamentally a right angled triangle. The following equation is used to calculate the volume:

$$(\text{Height of Backing} \times \text{Width of Backing}) \div 2 \times \text{Length of Backing}$$

Backing height matches the wall which it joins. In practice the length of backing will match the wall length, clearly the gateways were not backed as this would block movement. All measurements for the length of backing are internal, and, similar to the method calculating wall lengths, the width of the backing of the east and west walls is removed from the length of backing for the north and

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[34] Veg. III.8: 'The turf is cut around with iron tools, retaining the earth in the grass roots, ½ foot hight, 1 foot wide and 1½ foot long.' Caespes autem circumciditur ferramentis, qui herbarum radicibus continet terram; fit altus semissem, latus pedem, longus pedem semis. The Roman foot is shorter than the British Imperial measure, being 29.6 cm rather than 30 cm, Walthew, 1981, 15; Hill, 2004, 4. See also Coles, 1973, 81; *Id.*, 1979, 136; Jones, 1975, 30. It should be noted that not all turves may have been cut to this Vegetian standard, Jones, 1975, 80, obviously the volume in turf structure remains the same, the number of turves, however, is used for calculations relating to work rate.

[35] Exact volume $0.01945m^3$.

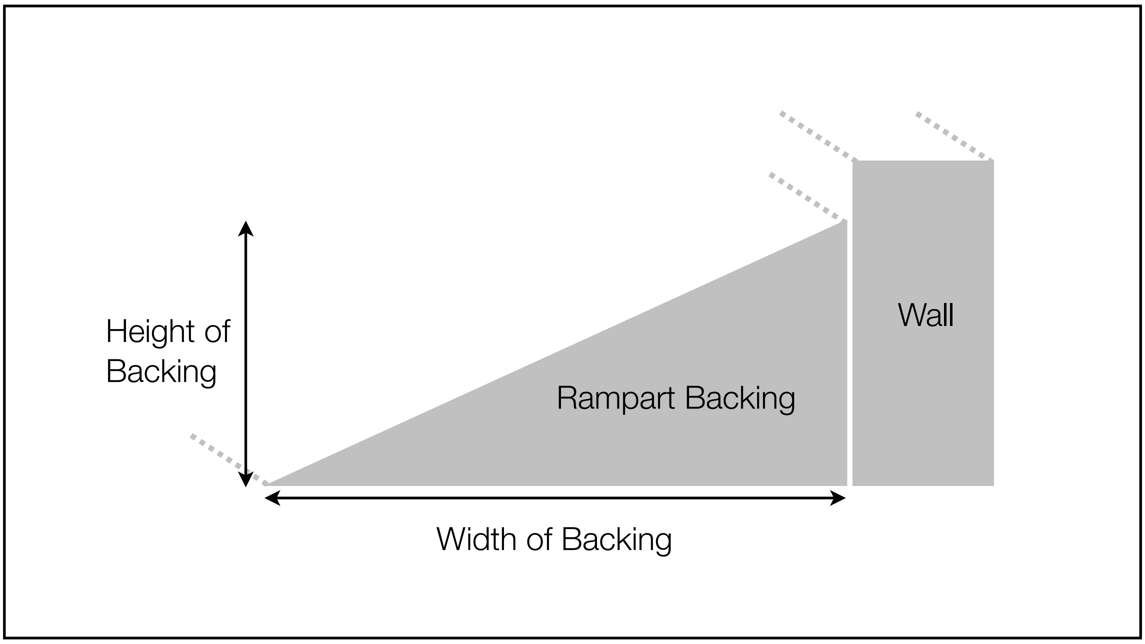

Fig. 4.8: Section of fort wall with rampart backing and variables. Not to scale.

south walls. This prevents the repetition of volume in the corners of the structure, as demonstrated on Figure 4.2.

§ 4.6.3 | Vallum Mounds

The rampart backing is not the only non-rectilinear turf construct associated with the Wall. The vallum mounds, which flank the vallum ditch to the south of Hadrian's Wall, are also turf built. Their different shape, shown on Figure 4.9, necessitates different calculations in order to estimate volume. In effect the mounds form half a cylinder, and thus their volume can be calculated as such:

$$\pi \times (\text{Mound Width} \div 2) \times (\text{Mound Height} \div 2) \times \text{Length}$$

Clearly the mound width variable can be informed by excavation, however, the height is open to discussion. In this case, the height of the highest surviving mound is rounded up from 3½ft high to 4ft giving a height of 1.22m.[36] The decision was taken here to round-up the figure due to the erosion of the materials. This is little different from the use of a reasonable height for the curtain wall which is, itself, far taller than any of the surviving sections. Consequently, 1.22m is used as this is based on a rounded sample from the Vallum in the Housesteads - Greatchesters area.

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[36] Simpson, 1976, 116.

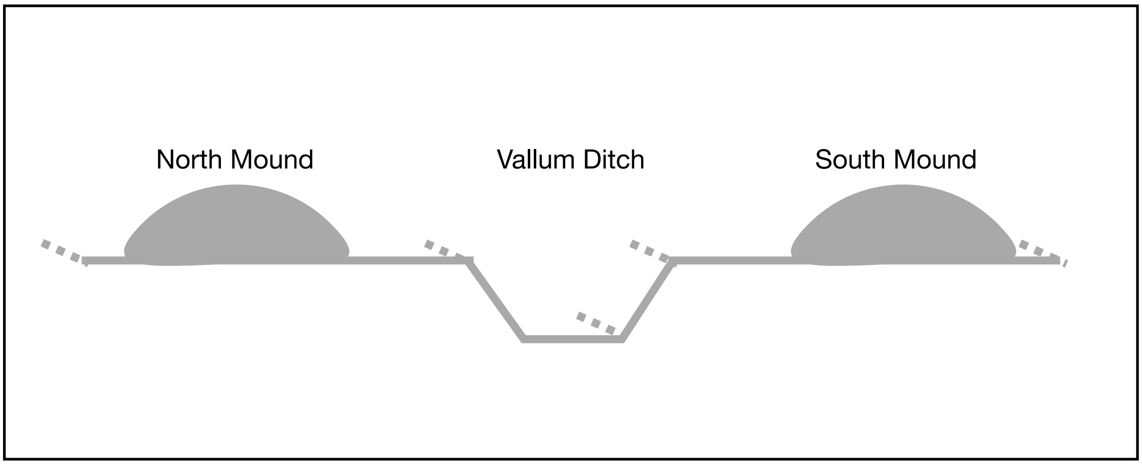

Fig 4.9: Cross section through Vallum. Not to scale.

§ 4.7 | Timber Volume Calculations

The vagaries of the archaeological record make the timber aspects of Roman forts a lacuna. With such little evidence on the Wall, the work on Inchtuthil provides a model.[37] The core methodology of calculating timber volume on the Wall involves calculating how much timber is used per cubic metre of turf. This takes place for each use of timber, e.g. parapet walk on forts, gateways *etc*., and is then 'scaled up' depending on the structure's turf volume. Firstly, however, the different types of timber constructions which make up forts, milecastles and ramparts need to be categorised; then the timber volume per cubic metre of turf volume can be calculated. In line with the project methodology, alternatives are included for the purposes of discussion, configurations with the least materials are used for calculations.

§ 4.7.1 | Fort and Milecastle Ramparts

Ramparts on forts and milecastles possess various timber features in their structures. At the most basic level this forms the parapet, which has a substructure below the walkway, and merlons of the type seen on Trajan's Column in Scene LXV, Figure 4.10.[38] The timbers used are assumed to be 10cm x 10cm with cladding formed

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[37] All dimensions and volumes used here are taken from Shirley, 2000, Chp.5.

[38] It is noteworthy that this scene is of a stone fortress. However, it is unlikely that this form was not reproduced in timber structures, especially given that units would construct in turf and timber and stone. This image is thus included to give some idea of both visual appearance and scale.

Fig 4.10: Scene LXV, Trajan's Column.

from wickerwork, in part accounting for the general lack of nails on the Wall. In the case of Inchtuthil, this gives a total volume of $48m^3$ of parapet supports above the rampart, $30m^3$ below and $43m^3$ of cladding: this gives a total of $121m^3$ of timber used in the parapet across the site.

The substructure of the parapet breaks down into two categories. The first, Substructure 1, is assumed to have been constituted by 10cm x 5cm timbers, one metre below the walkway. At Inchtuthil this would account for $16m^3$ of timber volume. The second type, called Substructure 2, is assumed to have the same dimensions as the parapet timbers, that is 10cm x 10cm. This size timber would give a total volume for Inchtuthil of $25m^3$.

The timber in the ramparts also has multiple possible configurations. The first, discounted in the Inchtuthil study for its labour intensive nature and the potential for warping,[39] was comprised of 2.5cm planks affixed to 5cm x 5cm supports. This would, at Inchtuthil, give a total of $22m^3$ for support timbers and $79m^3$ of boarding for a total of $101m^3$ of volume. However, these figures represent the volume of

[39] Shirley, 2000, 46.

timber required for a trapezoid with a 2m top width; as discussed above, this is not comparable to Hadrian's Wall. Thus, the figures require some alteration for use with Type I and II turf structures: for the former, the total needs reducing by 10% to represent the 1.8m top width; to conform to the latter, the figure requires an inflation of 50% to represent the 3m top width. These figures, included for the sake of comparanda, are 'Walk Plank 1', for Type I turf structures; and 'Walk Plank 2' for Type II turf structures.

The second possible walkway configuration is made from timber poles. These are 10cm diameter poles which would be used to form a walkway of some 250m^3 of volume at Inchtuthil. Again, these figures need scaling to match the different building types seen on the Wall: 'Walk Pole 1' and 'Walk Pole 2' represent Type I and Type II turf structures respectively. The third and final variable is that of split poles, with dimensions of 10cm x 5cm, giving a total volume of 125m^3 plus an extra 26m^3 for supports, across Inchtuthil. Once again, these figures need altering to represent the different building types seen on Hadrian's Wall, becoming 'Walk Split Pole 1' and 'Walk Split Pole 2' for Types I and II turf structures respectively. The final option is selected, in line with the methodology, of using the smallest measure.

The final aspect is that of access. This covers both access to the structure itself, through gateways, and stairs up and down the rampart walls. Gateways are discussed in depth in relation to Inchtuthil, including a breakdown of the individual aspects of the gateway as well as the towers.[40] This gives a total of 32.9m^3 of timber volume for a fortress gateway. Obviously, this needs to be altered to take account of the single gateway access to milecastle along the line of the Wall. The tower figure of 16.2m^3 of volume thus needs halving to 8.1m^3 to represent just one structure. Similarly, the values given for the tower walkway and tower platform need halving to account for the loss of one turret: this goes from 3.6m^3 to 1.8m^3.

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[40] Shirley, 2000, 46-7.

Thus a single portal gateway, inclusive of tower, can be estimated as possessing 21.2m^3 of timber volume.

Finally, access ways are subject to multiple configurations. Access 1 is considered to use 15cm diameter poles; Access 2 is made up of 15cm x 30cm poles with the third and final variant, Access 3, comprised of 30cm diameter poles. For the Inchtuthil study, the total volumes are based upon a presumption of 18 or 22 access ways for the fortresses, thus the total volume of access ways for the site is divided by the number of access ways, this gives the volume per access.[41] Access 1 is selected, in line with the methodology of using the lowest figures.

Naturally, not all of the aspects defined above that are applicable to fort and milecastle ramparts can be applied to the turf curtain. Both access ways and gateways are superfluous, though Hobley's experience at the Lunt, where the internal timber work was essential to maintain core stability,[42] means that the substructure is included. The parapet, as well as a rampart walk, are matters of debate, largely based around the presumed purpose of the Wall. In line with that stone wall, where there is no evidence for a wall walk, and the methodology of assuming the least impact, the parapet and rampart walk will be excluded for the turf curtain.

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[41] Shirley, 2000, 46.
[42] Hobley, 1967, 87.

The volume of each timber part is summarised in Table 4.1. Importantly, figures are included per m^3 of turf allowing scaling of the volume of timber to be related to the size of any turf structure.

Table 4.1	
Element	Timber (m^3) per $1m^3$ of Turf
Substructure 1	0.00056
Substructure 2	0.00088
Parapet	0.065
Access 1	1.66
Access 2	3.33
Access 3	4.42
Walk Plank 1	0.045
Walk Plank 2	0.075
Walk Pole 1	0.12
Walk Pole 2	0.195
Walk Split Pole 1	0.07
Walk Split Pole 2	0.12

Table 4.1: Timber per cubic metre of turf in ramparts.

§ 4.8 | Work Rates

The composition of Hadrian's Wall and its associated systems includes many different materials, consequently sources for work rates are diverse and cover various aspects of experimental archaeology. The main source for dry stonework is that of Chapman *et al.*'s Dalmatian research, this provides the closest comparison for the sort of work envisaged, and includes an in-depth methodology.[43] Mortared construction is considered in DeLaine's study of Caracalla's baths.[44] Turfwork is derived from Hobley's work at the Lunt,[45] as well as Shirley's Inchtuthil study.[46] Finally, Jewell's work at

[43] Chapman *et al.*, 1996 builds on Jewell, 1963; Hobley 1967, 1971, 1974, 1975, 1982 and Coles, 1973, 1979, specifically for dry-stone.

[44] DeLaine, 1997.

[45] Hobley, 1967; *id*., 1971; *id*., 1974; *id*., 1975; *id*., 1982.

[46] Shirley, 2000.

Overton Down provides further data for earthwork labour.[47] Using these sources allows the labour demand to be estimated for all the structures on Hadrian's Wall and its surrounding systems. Firstly, the length of the building season, the working day and the logistics of the work site need to be discussed.

§ 4.8.1 | The Building Season

A number of factors require consideration, first and foremost is the nature of the materials. Rain and freezing temperatures can affect the bonding of mortar;[48] similarly, turf cutting has to take place when the turf is moist, though not overly so.[49] Both of these factors limit the types of activity that can take place during the winter months in Britain. As a consequence of this factor, this study uses a 200-day building season, first suggested for the Wall by Robert Rawlinson in 1851 and supported by Kendal's study of the logistics associated with the Wall's construction.[50] This is contra Shirley's proposal of year-round building, albeit at a reduced rate during Britain's winter.[51]

Building during winter may well have taken place. The burden of organising the logistics may not have been the smooth 'clockwork' operation that is often expected of the modern military and transposed onto the Roman world.[52] Furthermore, the 200-day building season takes account of weather variability more than year-round building: whilst activities may have been reduced during the winter months, there would have been years with particularly wet or dry summers, this too would affect the total number of days available for building. The 200-day building season, in this case, should be seen as the average number of days per year that building could take place.

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[47] Jewell, 1963.
[48] Kendal, 1996, 137.
[49] Hobley, 1971, 17.
[50] Bruce, 1851, 94-5; Kendal, 1996, 137, 144.
[51] Shirley, 2000, 154.
[52] James, 2002, 8-9. See Chp. 2 for more discussion of retrojection.

§ 4.8.2 | The Working Day

The length of the working day is open to some discussion.[53] Should this be based around the number of hours of daylight available, which would equate to a figure as high as 12 hours a day during the summer; or should a more conservative modern western norm of 8 hours a day be selected? Shirley suggests an 8-hour day for year-round building,[54] which this study utilises, accounting for more daylight in the summer balanced by less in the winter. The 8-hour value has further benefits in that it is easy to inflate in order to consider different theories, changing to a 12-hour model requires the addition of 50%, similarly, a 10-hour working day model would need 25% inflation. Finally, the use of an 8-hour day allows modern comparanda to be developed, including calorific requirements set out by the WHO, vital for calculating the Wall's supply demands.[55]

Obviously, the methodology's use of the lowest figure results in the maximum construction time being estimated. This, however, can be altered along similar lines as the percentile inflation of the working day as a 50% increase in hours worked per day is directly proportional to completion. Thus an identical percentile decrease takes place in the completion time.

§ 4.8.3 | The Work Site

First and foremost it is important to understand that full 'paper strength' legions and auxiliary units seem to be a rarity in peacetime.[56] Similarly an entire legion would barely be able to

[53] One potential avenue of exploration here is the intensity of duty, the length of 'shift' needed to make the structure operate smoothly. This can be best informed by milecastles, with their need to function to allow traffic to pass balanced by their small size, and thus, limited capacity. Hill & Dobson, 1992, 37 suggest an intensity of duty of 8 hours on, followed by 8 off. This would be in line with the suggested working day here. The alternating pattern of 8 on/8 off could imply a 16-hour working day, albeit not in one stretch. However, the nature of the building work renders work by artificial light impossible. This time could be spent on duties such as caring for equipment or food preparation. Shirley, 2000, 94.

[54] Shirley, 2000, 154.

[55] FAO/WHO, 1973, 28; Foxhall & Forbes, 1982, 47. See §9.3.3.

[56] See §9.3.2.

physically fit on the work site of its fortress.[57] Consequently, entire full-strength units working on site can be discounted for both these reasons. The number of people who could physically work on the building sites of the Wall is a vital question as it affects the completion time of all structures, from the smallest turret to the largest fort.

Shirley proposes a workable solution of one person per *c*.14m^2.[58] Consequently, the various structures will be assessed both in light of the broad relevance of Inchtuthil, that is with half or a third of the force on site building, and to the underlying formula of approximately *c*.14m^2 per worker. This serves to highlight, however, that the most difficult task of all would be the organisation of the work site. For example, actions such as quarrying are beyond the remit of this study, the quarries are difficult to associate with the Wall and the work did not take place near the construction site; however, haulage around the site, equipment costs and shaping all form part of the quantitative survey. It is the organisation of the work force during the building season combined with the sequence of work and the supply of the site that would have been the most onerous task, certainly for a structure the size of Hadrian's Wall.

§ 4.8.4 | Stone Work Rates

The work rate calculations used here are based primarily on Chapman *et al*'s work in Dalmatia.[59] This provides the rate of work for various activities connected to stone construction, importantly, a low/high rate is included for each of the component activities.[60] These figures are shown in Table 4.2:

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[58] Shirley, 2000, 92. With, perhaps, an ideal being closer to 20m.
[59] Chapman *et al.*, 1996, Chp.5.
[60] Chapman *et al.*, 1996, 162 also uses an eight hour working day. Thus, there is no need to alter these figures.

Table 4.2		
Type of Work		Work Rate Per Day (m^3)
Haulage	Low	0.75
	High	2.5
Stonework	Low Quality	5
	High Quality	2.5
Mortared Stonework		0.25
Shaping		0.8

Table 4.2: Different work types and related work rates.

The type of work which best represents Roman practice is: high haulage, due to the availability of equipment for carrying and presence of roads;[61] low quality stone work, selected due to the lack of decorated stonework;[62] mortared stonework and shaping. Various parts of a structure would be worked with varying methods and to different standards, though on the whole the appearence of Hadrian's Wall was 'rough'[63] and thus the lowest specification is used both in line with the monument itself and the thesis methodology. This serves to calculate the lowest cost, again in line with the thesis methodology. Consequently, the make-up of each structure needs to be considered.

Roman stone walls, like their turf counterparts, were constructed with a rubble core. The ratio of core to facing stones differs per structure, and is shown on Table 4.3:[64]

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61 As noted in §3.4.1 and infra, haulage is the most likely on-site activity to have been open to non-Roman labour. However, it is impossible to quantify the form this labour would take, consequently this study assumes that haulage is executed by the Roman military building the structure.

62 Breeze, 2006b, 54, describes the Wall as 'not built to a high standard.'

63 Hill, 2004, 3; Breeze, 2006b, 54.

64 Note, turret measure based from average of milecastle figures as Kendal does not include a figure.

Table 4.3		
Structure	Percentage of Volume, Facing Stones	Percentage of Volume, Core Stones
Broad Curtain Wall	34.7%	65.3%
Narrow Curtain Wall	48.1%	51.9%
Broad Milecastles	49.6%	50.4%
Narrow Milecastles	62.0%	38.0%
Turrets*	55.8%	44.2%
Forts	54.7%	45.3%

Table 4.3: Percentages of core and facing stones per structure type.

Only the facing stones would have been shaped and then mortared, thus the work rates for mortared stonework and shaping are calculated only for the relevant percentage of a wall's overall volume. The remaining percentage was not shaped and was worked to non-mortared stonework figures.

The final factor which affects work rate of stone is working at a height through the use of scaffolding. This will have the greatest effect on the turrets and the milecastle gateways, as these are the tallest structures. The rate at which scaffolding slows the work is shown on Table 4.4:[65]

Table 4.4	
Wall Height (m)	Volume Lifted Per Person Day (m^3)
6+	2.5
5	3.0
4	5.0
3	10.0
0-2	No extra labour/scaffolding

Table 4.4: Volume lifted per person day at different scaffold heights.

[65] Chapman *et al*., 1996, 163-4.

The percentage of the structure's volume that lies at each point of height will be divided by the rate of volume that can be lifted at that height. This will give the amount of extra person days required to build the structure due to its height. This process, however, becomes more complex for turrets and towered milecastle gateways. This methodology assumed that the wall widths are the same over the entire height of the structure, something that is not the case with turrets and milecastle. Thus, two separate calculations are made, one for the ground floor, and a second for those above. The result is then combined in a similar manner to the calculations for stone wall volume including offsets.

§ 4.8.5 | Turf Work Rates

The first requirement of turf construction is the need to cut turves. Hobley, at the Lunt, demonstrated turf cutting at a rate between 4.5 and 6.5 per person hour. Consequently, 5.5 turfs per person hour is taken as the average rate of cutting, multiplied by eight to simulate a full working day, giving a total of 44 turfs per person day. The calculation for the number of days turf cutting took is:

Number of Turves in Structure ÷ Number of Turves Cut Per Person Day

Once cut, the turf needed hauling, here the Dalmatia study provides figures for hand haulage. An average of 28kg per trip could be carried and 170 trips from up to 100m away from the site could be made in an 8-hour day.[66] This needs to be modified before it can be applied to Roman turf structures, the area around the installation only needed stripping to a maximum distance of 50m, often less.[67] It is therefore assumed that 50% more trips could be made as 50% less distance was being covered. This gives a figure of (170+85) 255 trips per person day. The total weight hauled is calculated by the

[66] Chapman *et al*., 1996, 162. Haulage in Chapman *et al.*'s study was informed by Erasmus, 1965.

[67] Hobley, 1967, 87; Jones, 1975, 30. Jones mentions that the maximum the turves could be carried was 50m, though he states that it was not necessary to go any further from the fort site than 46m from the inside of the rampart. Hobley states that 38m was the maximum required distance. Hobley, 1967, 88.

average weight carried (28kg) by the number of trips (255), resulting in a total of 7,140kg per person day. Each Roman turf weighs between 32kg and 34kg,[68] giving 33kg as median, thus (7,140 ÷ 33) would result in 216.36 turves hauled per person day. The turves, as can be seen, are 5kg heavier than Chapman *et al*'s figures for hand haulage. This does not effect the formula as this is related to the total haulage weight per day, which is calculated from the lower figure. The key difference is how the weight is carried, with the extra encumbrance quite literally shouldered by a two man team with one acting as a loader to place the turf onto the back of the other.[69] Thus the number of person days it would take to haul the turves into position can be seen in this formula:

Turves in Structure ÷ Turves Hauled Per Person Day

Hobley stresses that the laying of turfs took place at the same rate as their cutting. Thus turfs would be laid at the rate of 44 per person day. It may be noted here that a scaffold figure has not been mentioned. Whilst there is one given in the Dalmatia study this is not applicable: the Dalmatia study refers specifically to stone structures and not to turf.[70] Furthermore, the simulation at the Lunt shows that the progressive laying of turves formed a working face.[71] The reconstruction reported no need for the use of scaffolding, therefore it is unlikely that any would have been needed when building the turf wall. This is similar to marble extraction techniques, for example.[72] Consequently, the number of person days required for turf laying is:

Turves in Structure ÷ Turves Laid Per Person Day.

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[68] Coles, 1979, 136.

[69] This can be seen on Pl.12.4 in Hobley, 1982, 230 and is informed by Trajan's Column.

[70] Chapman *et al*., 1996, 158-9.

[71] Hobley, 1975, 21.

[72] Ward-Perkins, 1971, 140.

Core haulage is the remaining aspect to be considered. The core takes up one third of the rampart's overall volume, therefore the following formula is used to see how many person days the hauling of the core took:

(Core volume ÷ Turf Volume) ÷ Turves Hauled Per Person Day.

This has the effect of calculating the theoretical number of non-existent turfs in the core, and using the turf haulage rate to calculate how long it would take to haul materials to fill the core. Combining the core and turf results gives the total volume for the rampart.

The final aspect is excavation of earth to form ditches, this can be seen on both the stone wall, and the turf wall west of the Irthing. Previous measures used for working with turf are not wholly applicable here as turf cutting relates to the creation of turves rather than the wholesale process of excavating a trench. Consequently a different figure needs to be calculated: in this case it is Overton Down that provides the necessary comparative data.[73] Here it is stated that primitive tools (e.g. deer antlers) would excavate at a rate of 0.91m^3 an hour. Modern tools, by comparison, would excavate at a rate of 1.09m^3 per hour, almost 20% more. Consequently, an average of these measures is taken as Roman tools are neither ancient in this sense or made with modern materials and techniques.[74] This equates to 1m^3 an hour, totalling 8m^3 for an 8-hour day. Consequently, the formula used to estimate how long a ditch with little shaping or complex work, would take to complete is:

Volume to be Excavated ÷ Excavation Work Rate

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[73] Jewell, 1963, chp. VI. The people working on Overton Down were not trained in the use of the tools and yet were able to excavate at a high rate. More experience would perhaps have allowed greater work rates to be achieved.

[74] There could be some cause for debate here. There is a noted similarity between Roman tools and their modern steel equivalents, furthermore, the fact that there has been 'little change in the hand tools over the past three or four millennia' would give credence to the use of the modern figure for Roman tools (8.72m^3 per day). It may even have been higher given the skill level of the Roman soldiers. Nevertheless, this is an area of debate beyond the scope of this work, thus caution is erred upon and the lower figure is used. See Hill, 2004, 55.

§ 4.8.6 | Vallum Mound Work Rates

The Vallum mounds are not merely upcast heaps, but were at various points revetted with turf.[75] Consequently, a percentage of the mounds would have been worked to different rates from the core. This is calculated similarly to the work rates for turf ramparts in that the mound's volume is divided into core and kerbed areas. Although turf's natural lack of survival makes estimating core/kerbing ratios difficult, there is evidence from the Birdoswald - Castlesteads area which shows the core would account for the central third of the structure, with the kerbing flanking either side.[76] Thus a figure of one-third is presumed to represent the core, with the remaining two thirds attributed to the revetting. The work rate of the one-third core volume is calculated in the same manner as the core of turf ramparts; the revetted work rate is calculated in the same manner as turves laid in normal ramparts.

§ 4.9 | Timber Work Rate

Timber work rates are calculated in the same manner as timber volumes, using Shirley's Inchtuthil study as its basis. The work rates for the various components of the structures at Inchtuthil are divided into their volumes, thus providing a measure of how many cubic metres could be worked in a person hour. This figure is then scaled for an 8 hour working day. The various elements, their volumes and final work rates are shown on the Table 4.5:[77]

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[75] Simpson & Richmond, 1935, 215; Simpson & Richmond, 1937a, 159; Simpson, 1976, 116.

[76] Simpson & Richmond, 1937a, 159.

[77] Figures based on Shirley, 2000, 112. Note: double gateways include two towers; single gateways include one tower.

Table 4.5				
Structural Element	Inchtuthil Volume Total	Inchtuthil Man Hours	Hours Per m^3	Days Per m^3
Parapet	$137m^3$	4,865	35.5	4.44
Rampart Planks	$101m^3$	3,670	36.34	4.54
Rampart Poles	$250m^3$	7,055	28.22	3.53
Rampart Split Poles	$151m^3$	7,175	47.52	5.9
Double Gateway	$32.9m^3$	2,787.75	21.9	2.73
Single Gateway	$17.87m^3$	1,661.25	23.24	2.9

Table 4.5: Labour rate per cubic metre of timber for each structural element.

Access ways differ in their execution as a figure of 680 hours is given per accessway.[78] Consequently simply dividing this by eight to simulate the working day gives how many person days are needed per accessway: in this case 85 person days. This serves to highlight how manpower intensive it could be to construct relatively complex elements of a structure in timber.

§ 4.10 | Building Team

This is intimately connected to the management of the work site, supra §4.8.3. There is one very important basic assumption: that Roman forts and fortresses were originally designed to be constructed by the unit which they would house. This is derived from the fact that the design of Roman military architecture is rooted in the development of the marching camps seen in the Roman Republican period.[79] These, in turn, give way to the more permanent structures concretised in the form of the forts on the Wall. This fundamental link connects the garrisoned unit to the size of its fort as, when on campaign, the unit only had itself to rely on to

[78] Shirley, 2000, 112.

[79] Connolly, 1998, 242. Both Imperial forts and camps share the same broad shape, division through the *via Praetoria* and *via Principalis* and the continuity of the *praetorium* and tribune's areas. The biggest change between the two periods was that of the reorganisation, and thus removal, of maniples, nevertheless, the *porta Decumana*, so called due to its proximity to the tenth maniple, kept its name. This points to a strong continuity of form from the time of Polybius onwards.

construct the camps. Similarly, siege works such as those at Alesia and Masada could only have been built by the besieging army, with no help from the civilians of the site. Importantly, these siege works, with closely integrated forts on the line of their contravallation wall, closely resemble Hadrian's Wall. This relationship can be seen in the late Republic with the appearence of 'twin legionary' fortresses, for example at Mainz,[80] which sit back-to-back rather than in one super-size fortress.

As a consequence of this relationship, it is assumed in this study that all structures intended to house soldiers would notionally be constructed by their garrisons. It cannot be stressed clearly enough that the situation on the ground, whereby variables of demand and supply of both labour and materials would fluctuate, would have differed. This could includes the use of non-Roman military labour being used in off-site activities, their importance to this process is an unknown and could therefore have a great effect on the completion time of the main structures. Nevertheless, this 'blueprint' for sit construction is derived from years of active service and can provide valuable insight into the practices of the Roman military. Consequently, the build teams will be tested against the recommended numbers that can fit upon the work site as well as this notional ideal. Furthermore, with a chronology that covers the construction of the Wall, it is possible to test these theoretical build teams against the number of soldiers required to complete the structures in the known time frame.

§ 4.11 | Internal Structures: the 'Inchtuthil Ratio'

At various sites along the Wall a full survey is an impossibility due to the vagaries of the archaeological record. Internal buildings, when compared to the walls of the structures, have received far less attention through the history of their excavation. This is neatly demonstrated by the emphasis on Milecastle gateways for much of

[80] Housing *legio IV Macedonica* and *legio XXII Primigenia*. Connolly, 1998, 212.

their analysis.[81] In some cases, Castlesteads for example, recovering the internal plan, let alone the dimensions of any structures, is an impossibility. However, by utilising the information generated in Shirley's study of Inchtuthil, it is possible to estimate the total amount of work required to construct any given fort. This is vital as it provides a method for estimating the demands exerted by the internal buildings that would otherwise be impossible. Similarly, this process allows the estimation of aspects like roofs, of which the specifics are completely unknown for the Wall.

A detailed breakdown of how much effort is required to construct all the different aspects of Inchtuthil is given.[82] Roman forts were, in effect, scaled according to the size of their walls, the longer the walls the larger the surface area enclosed, thus the greater number of buildings present. This allows estimation of the total quantities of materials and work rate by comparing what has been excavated and recorded, and inflating this incomplete record to match that of Inchtutil's. Walls, according to Shirley's study, account for 14% of the total labour and material demand of a fort. Thus, the fort walls can be scaled up to reflect the full demands of material and work rate for a complete fort. This method is used to estimate the total volume and thus labour cost of a fort and is referred to as the Inchtuthil Ratio.

§ 4.11.1 | Turf and Timber Milecastle Internal Buildings

This wall-to-internal-building ratio is based upon forts and cannot, therefore, be applied to milecastles. These suffer from a similar lack of excavation on their internal structures. However, a different method is used to estimate the demands levied by the internal buildings. Milecastles contained a barrack block used to house soldiers, thus the results of Inchtuthil's quantitative survey of barrack

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[81] Breeze, 2006b, 67.
[82] Shirley, 2000, Chps 5 & 7. Summed up in Table 7.51 and 7.52, 155-6.

blocks can be used to create an 'average' barrack, which is then applied to each milecastle.

Of Inchtuthil's 66 barracks, blocks XVII, XVIII, XLIX, L and LI were excavated in detail and these are used to inform the turf built milecastle's barrack blocks west of the Irthing.[83] There are alternative projections made for barrack blocks of 20 and 30 degree roof pitches. The former is preferred here as the greater roof pitch uses 4.6% more materials,[84] thus the lowest figure is chosen in line with the project methodology. The total quantities of timber required for the five barrack blocks are shown on Table 4.6.

Table 4.6	
Block	Timber Volume (m^3)
Barrack Block XVII	110
Barrack Block XVIII	121
Barrack Block XLIX	123
Barrack Block L	128
Barrack Block LI	118
Average	120

Table 4.6: Timber volume per barrack block at Inchtuthil.

Consequently, an extra 120m^3 of timber is applied to each of the turf and timber milecastles on the Wall west of the River Irthing. The labour cost of this structure can be calculated through Shirley's projections. Shirley lists all 66 barrack blocks as taking a total 618,248 person hours.[85] Divided by 66 this gives 9,367.39 person hours per barrack block. Assuming an eight hour working day, each barrack block adds 1,170.92 person days labour for each milecastle. These quantities and labour values are also applied to the milefortlets of the Cumberland coast, alongside the milecastles west of the Irthing, due to the similar materials used in construction.

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83 Pitts & St Joseph, 1985, 157/60; Shirley, 2000, 54.

84 Shirley, 2000, 55.

85 Shirley, 2000, 140, Table 7.42.

§ 4.11.2 | Stone Milecastle Internal Buildings

The stone milecastles' internal buildings are informed by one of the best preserved forts on Hadrian's Wall, Housesteads. Whilst a full quantitative survey of the fort is impossible given the scope of this thesis, a barrack block can be quantified and then applied to the stone-built milecastles along the Wall's line. This is required as even well excavated sites, like MC40, have had little concentration on their internal buildings. Thus, as with turf and timber structures, a quantified stone barrack block will be applied to each of the milecastles. There are some atypical milecastles on the Wall, notably MCs 47, 48 and 52, whose size meant they could accommodate a greater number of personnel. Thus they will be modelled to include two barrack blocks. The excavation of 1960 at Housesteads provides a complete plan of a Hadrianic-era barrack block, number XIV on Bosanquet's plan of the 1898 excavations, which can be seen on Figure 4.11.[86]

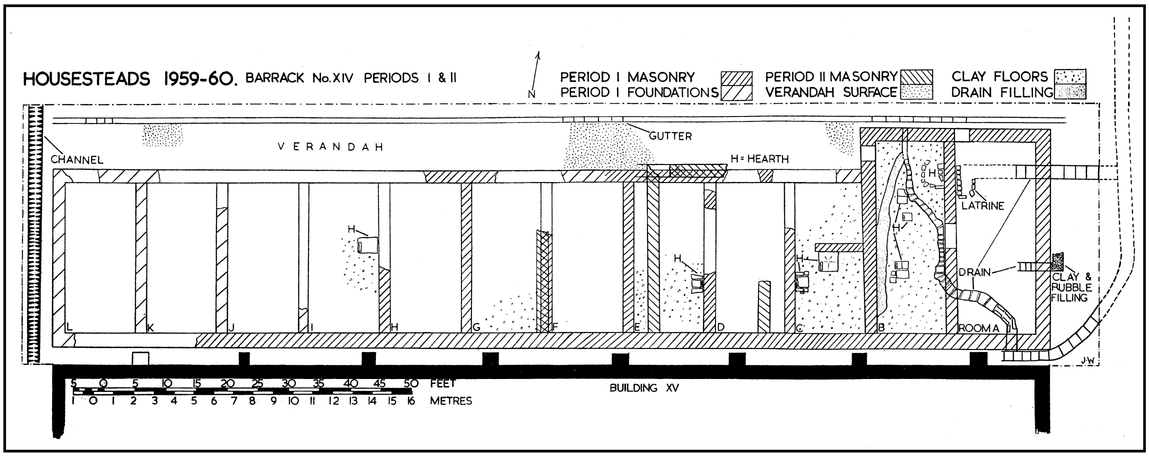

Fig. 4.11: Excavated plan of barrack block XIV, Housesteads.

The large rooms, on the east of the diagram, are quarters for the centurion. Given that centurions would probably not be present in milecastles these two rooms are excluded from the quantitative survey. The *contubernia* are broadly identical in size, measuring 3.35m x 7.62, thus enclosing a total internal area measuring 36.92m east-west, 7.62m north-south. This is interspaced with seven internal walls 0.46m in width, by 7.62m in

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[86] Bosanquet, 1904, 193-300; Wilkes, 1961, 279-99.

length. The Period I masonry ends after the 8th chamber, this reconstruction presumes this to be the end of the structure, this would be the correct size for the number of soldiers in a *contubernium*, and presumably in the milecastle barrack block. The external walls are 0.61m thick, with the internal walls measuring 0.46m. Since doorways were impossible to locate the average measurements were taken from the Wall's turrets,[87] giving a height of 1.778m and an opening of 1.02m. This gives a total width of opening per barrack block of 8.16m.

Shirley's work on the five excavated barracks at Inchtuthil allows an estimate of the required volume of wood for the roof. This is shown on Table 4.7 and assuming the same 20 degree angle as above.

Table 4.7: Roof timber volume per barrack block at Inchtuthil.

Table 4.7			
Barrack Block	Roof Timber Volume (m^3)	Roof Shingles Volume (m^3)	Total Volume (m^3)
XVII	48.78	18.17	66.95
XVIII	54.19	20.85	75.04
XLIX	51.97	21	72.97
L	54.59	22	76.59
LI	49.78	20	69.78

[87] Wilkes, 1961, 283. See §4.4 for estimated doorway heights, quantitative survey of turrets has revealed the average opening, see §A2.16.

Table 4.7			
Average	51.862	20.404	72.266

For the timber labour, Shirley contains information about roof framing for barrack blocks.[88] Here 1,793 hours are required for roof framing. The creation of a weather envelope on the roof required a further 2,460.56 hours,[89] giving a total 4,253.56 hours. This equates to 531.7 person days, assuming an 8 hour day, and will be applied to each barrack block in the quantitative survey. In terms of calculating stone labour, the methodology established above is used. The barracks are assumed to have the same facing/core ratios as turrets, due to their similar wall widths. This does not include the atypical north wall of the stone wall turrets, which recess into the curtain.

Table 4.8: Barrack block results applied to stone milecastles.

Table 4.8 shows the results of the quantitative survey of block XIV that will be applied per barrack block in the stone milecastles.

Table 4.8					
Block	Stone Volume (m^3)	Timber Volume (m^3)	Stone Labour (person days)	Timber Labour (person days)	Cost (£)
XIV	312.60	72.27	1,091.90	531.70	401,181.81

§ 4.12 | Quantitative Survey

The quantitative survey is the final step for this information, it is the culmination of work rates, volumes and materials to provide a final fiscal figure. This figure can be broken down into two types: material's cost, related to volume; and labour cost, related to work rate. These figures were discussed with a professional quantitative surveyor in 2002 and are thus a reflexion of the costs of the time.[90] This is shown on Table 4.9:

Table 4.9: Fiscal value for labour and materials correct to 2002.

[88] Shirley, 2000, 123, Table 7.18.
[89] Shirley, 2000, 134, Table 7.35.
[90] These can be updated by using the *Quarterly Building Price and Cost Indices* published by the Department of Trade and Industry.

Table 4.9			
Feature	Relation	Value (£)	Unit Used
Labour	Total Person Days	120	per person day
Supervision	Total Person Days	10% of Labour	per person day
Turf	Material Volume	40	per cubic metre
Timber	Material Volume	150	per cubic metre
Stone	Material Volume	500	per cubic metre
Equipment	Total Person Days	10	per person day
Scaffold	Total Person Days	20	per person day

Of course, there must be some discussion of what such figures as a fiscal cost actually mean. Obviously the Roman constructors could not have planned out the Wall in the manner shown here, and there is no doubt that they would not have done so in a value of pounds sterling. The values generated are two-fold in use. Firstly, and most simply, they provide modern and contemporaneous comparanda. Considering the latter, the type of data generated here is directly comparable with similar quantitative studies, DeLaine's and Faulkner's to give two examples,[91] which provides a framework for comparison. In turn, questions, such as how 'military' expenditure and largesse on the army compares with civilian, can be assessed in light of such data. Modern comparison, whilst on a surface level seem far from worthwhile, can be used to understand the impact such buildings and structures have. How does, for example, Hadrian's Wall compare with large-scale modern building, would it carry the same or contextually similar power?[92]

As noted above, the final fiscal value, doubtless the most controversial aspect of this study, should be seen in the context of surplus labour. It demonstrates the labour resource available,

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[91] On the Baths of Caracalla and Late Roman civilian settlements respectively.

[92] DeLaine, 1997, 194 contains some discussion comparing Caracalla's Baths to Suleiman's mosque in Istanbul, St Peter's Dome in Rome and, most recently, Grande Mosquee Hassan II of Casablanca in 1990 drawing a connexion between autocratic rulers and large scale structural largesse, showing that such parallels are worthwhile.

creates comparisons between both modern and contemporary examples, and shows what could be constructed through its use.[93] Understanding the scale of such undertakings is of key importance when considering structures like Hadrian's Wall, a factor that Shirley comments upon,[94] the application of a fiscal value is another means

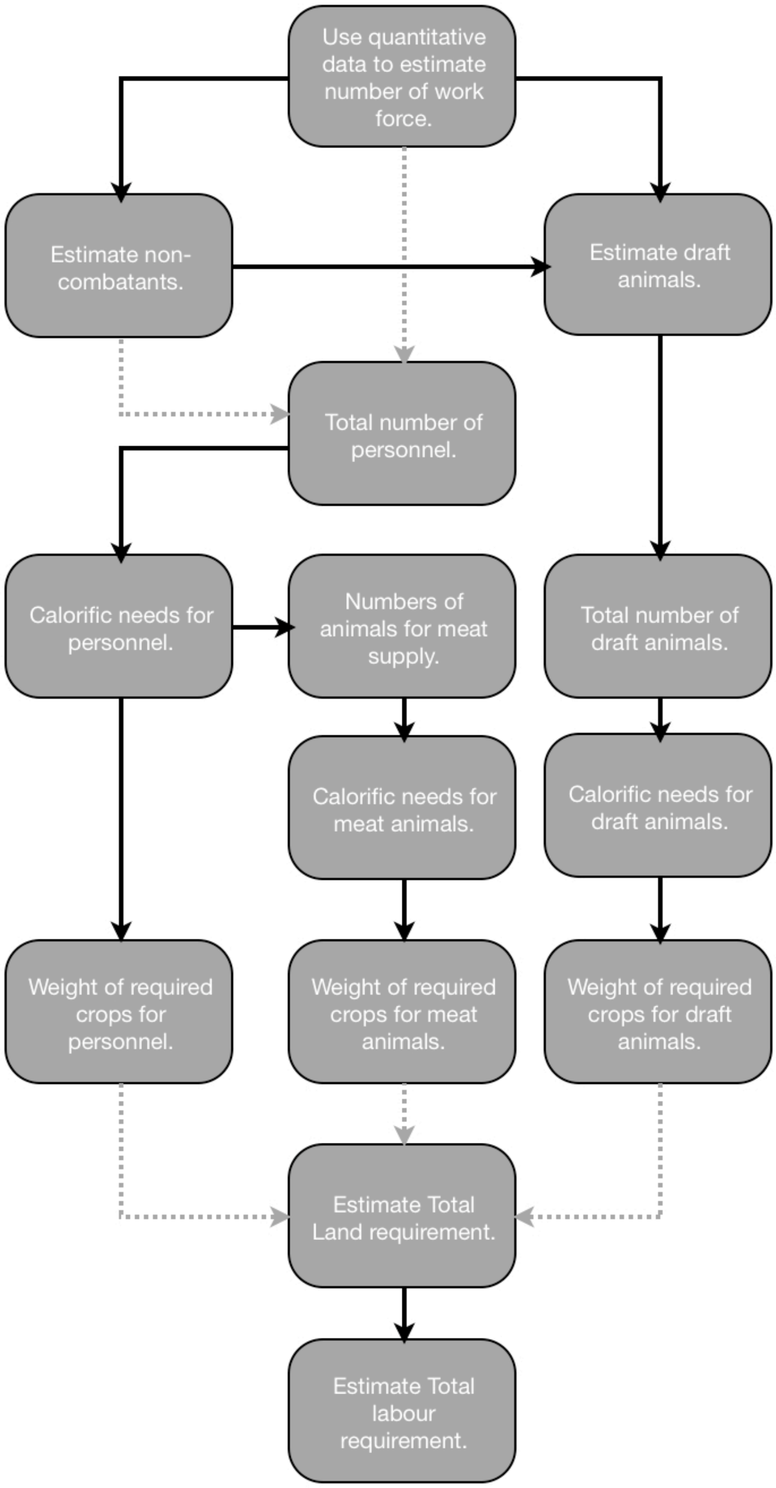

Figure 4.12: Flow chart of supply quantification process.

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[93] Faulkner, 1998, 37-8

[94] Shirley, 2000, 8-9.

by which the archaeologist can come to some understanding of a structure, its place in the wider world and the concepts it embodies.

§ 4.13 | Supply Calculations

The estimation of supply relies on a number of factors. First and foremost is the type of supply: is food the only aspect, or are equipment and materials included? This study is limited to the former option as it best represents the 'supply situation under normal circumstances', of which food accounts for some 90% of a unit's total supply weight.[95] Figure 4.12 shows the process of supply quantification in a flow chart. The black lines indicate processes requiring equations, whilst the grey dotted lines show addition, e.g. where the total number of personnel is the sum of the work force and its non-combatants.

Large quantities of materials are required in establishing a military unit, but these do not form the bulk of regular supply with their dissemination only taking place during the raising of a new unit or in preparation for a campaign.[96] With this criterion in mind, the following variables need to be established: the number of soldiers needing supply; the amount each soldier would consume; the number of animals the military would use; the amount the animals would consume; the carrying capacity of the land; the labour demand of the work.

The total number of soldiers along the line of the Wall has been open to much interpretation, with numbers as high as *c.*40,000 postulated.[97] The quantitative survey, however, provides a new method of assessing the amount of soldiery in the region, however, there is some debate as to the number and status of 'non-combatant' personnel within the Roman military.[98] It may well be the case that *calones* and *lixae*, military slaves and civilian contractors

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[95] Roth, 1999, 2, 3, see §9.1 for more.
[96] Breeze, 1984, 269-71, see §9.3.1 for more.
[97] Breeze, 2006b, 43.
[98] Roth, 1999, 93-102; Whittaker, 2002, 208. See §9.3.2 for more.

respectively, were supplied by the military.[99] This would increase the demand as the numbers of people requiring supply would swell. As a consequence, multiple projections will be made both including and excluding 'non-combatants', who are estimated by calculating a ratio based upon their numbers compared to the soldiery.

Consumption rates and crop types are compiled through comparative studies. These can range from models based on the recommendations of the United States Quartermaster Corps. to the application of the ancient sources.[100] Here, calorific, protein and water intakes, as well as the foodstuffs used to deliver these, are suggested to meet the daily demands of those being supplied. Thus the demand per year is estimated by the following calculation:

(Number of Soldiers x Weight of Ration per day) x 365

The Roman army, however, was not just a force of soldiers, but also included animals. These ranged from donkeys through to oxen, unfortunately, the numbers of animals per unit is unknown, as are the species. This latter point has a direct effect on the consumption, as oxen consume far greater amounts than donkeys. To reflect this the median consumption of Roman animal species in the north of England is used. Similar to the calculation of 'non-combatants', a ratio of animals per soldiers is used to estimate the total number present. This is derived from comparative data which includes the Napoleonic era and the American Civil War. There is an added layer of complexity to the calculations for animals as they require different sources of sustenance, namely green fodder and hard fodder. These can, however, be replaced by pasturage, albeit a much greater amount is needed. Consequently, projections are included for both fodder and pasturage. The following calculations are used for estimating the demand of foddered animals on the landscape per year.

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99 Roth, 1999, 93-102; Martins, 2005, 19.

100 Engels, 1978, 123; Polyb. 6.39.13.

(Number of Animals x (Green Fodder Intake per day + Hard Fodder Intake per day)) x 365

Pastured demand is estimated thus:

(Number of Animals x Pasturage Intake per day) x 365

The total demand placed on the landscape is calculated from the sum of grain demand for the soldiers and for that of the animals. Estimating whether this can be supported by the landscape requires a knowledge of the environment which is not possible due to the nature of the data.[101] Thus, in line with the methodology of utilising lower figures, a low carrying capacity for the land is presumed. Again, through lack of data, this is taken from comparative studies, in this case Manning's 1975 study of the carrying capacity of Welsh land.[102] Here a yield of 10 bushels an acre is presumed,[103] a measure that would be considered poor by the pre-mechanised standards of the 18th Century. Different crops, however, have different weights per bushel. Alfalfa, for example, weighs 27.22kg/bushel, whereas Barley weighs 21.77kg/bushel.[104] The carrying capacity of one acre is calculated with the following formula:

Bushel Weight in Kgs per Crop x 10

The demand exerted on the landscape by the soldiery can then be calculated with the following:

((Number of Soldiers x Weight of Ration per day) x 365) ÷ (Bushel Weight in Kgs x 10)

This supplies the number of acres of land required to support the soldiery, which is then converted into square kilometres. Identical formulae are used for the green and hard fodder of the animals,

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[101] Dumayne, 1994 strongly asserts that the data can be connected to a single event, in this case the construction of the Wall. Hanson, 1996 categorically refutes this.

[102] Manning, 1975.

[103] One acre is 4,046.86m^2.

[104] Murphy, 1993, was used as standard for bushel weights of differing crops.

substituting the first clause of the above formula with the relevant calculation. The second clause is complicated, however, by the fact that different types of plants can compose the different fodder types, each with different bushel weights. In this situation an average of the relevant weights are used in calculations.

§ 4.13.1 | The Labour Cost of Supply

Whilst there little information specific to working the land of the Tyne-Solway isthmus in the Roman period, Columella[105] provides vital information relating to the activities required to work land and the amount of time each would take. These are worked per *iugerum*, which equates to 2,630.5m^2,[106] and are estimated in person days.[107] Thus the total estimated land dependency can be used to calculate the labour cost of working the land to support the military.

The following calculation is used to estimate the number of hours required to work the land:

Number of *Iugera* x Hours Worked per *Iugera*

This total number of hours is then divided by the length of the working day, eight hours, to estimate the number of person days needed to work the land:

Total Hours Worked ÷ Hours in Working Day

This estimate of person days then needs to be divided by the number of days in the building season to give the total estimated number of personnel that would be needed in order to maintain supply. Columella claims that agricultural work could be carried out

[105] Columella *Rust*. 2.12.

[106] *Circa* 0.65 acres, 0.00226km^2.

[107] Columella gives no data as to how long he considers a working day. Since year round work is proposed it is presumed that the eight hour day suggested in §4.8.2 is valid for Columella's projections. Thus the four person day estimate for ploughing, see §9.4.1, is assumed to take 32 hours.

over 250 days in a year.[108] Whilst this related to the Mediterranean the specific relevance of the source to agriculture means this value is preferred for the working season over the 200 day building season. This uses the following formula:

Total Person Days ÷ Days in Building Season

§ 4.14 | GIS

Geographical Information Systems (GIS) is used within this thesis to both model test functional interpretations of the Wall and test the landscape from 'within'. The best example for the former is of Woolliscroft's signalling theory, whose methodology did not include any GIS based modelling.[109] Viewing the landscape through viewsheds and line of sight tests effectively places an 'agent' into the model and allows not just an assessment of site inter-visibility, but more general views of the landscape to be considered. Such questions as where parts of the Wall are visible from, which element has the greatest visibility, how often one type of interval structure can be seen to the exclusion of others can all be answered through GIS. These are all vital questions in understanding the impact the Wall had on the space in which it occupied.

The use of GIS, however, requires an understanding of its limitations and biases. Key amongst these is the nature of the data, GIS handles utilitarian and functional data very well: energy costs, proximity to good land, availability of markets, best defensive locations, *etc*. These factors are all quantifiable and easily entered into a GIS; however, post-processural theories have moved away from the quantifiable and economic basis which characterised functional landscape discussion. The use of GIS to answer questions beyond functionalism, interrogating the data and landscape from the perspective of cultural mediation,[110] is the core

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[108] Columella *Rust*. 2.12.8-9.

[109] Woolliscroft, 2001, Chp.1.

[110] Witcher, 1999, 13-4; Favro, 2006, 332.

of reconciling the functional roots of the process with the theoretical nature of the study. Considering the physical and visual reality of the landscape[111] serves to emphasise the non-quantifiable factors which shape the world.

§ 4.14.1 | Hardware, Software and Process

The hardware used was a late 2007 Apple MacBook, 2.2 Ghz Intel Core 2 Duo processor, 4 G.B. R.A.M. The primary operating system was Mac OSX Leopard, version 10.5.8 at the time of writing. The GIS software suite used was ArcGIS 9.1 running on Windows XP Professional SP2, either as a virtual machine through Parallels Desktop Build 3186, or natively through Boot Camp 2.0. Ordnance Survey contour data was collected through DigiMap, downloaded and appended using MapManager 6. From this a Digital Terrain Model (DTM) was created to 10m accuracy in ArcMap. Locations of sites were stored on Access 2000 databases for Windows XP, and added as data layers. Calculations were performed on a combination of Microsoft Excel 2004 for Mac, and Numbers ’08.

§ 4.15 | Conclusion

The above has shown that a large scale structure, like Hadrian’s Wall, requires a complicated methodology drawing on a number of sources in order to give as full a treatment as possible. Throughout, one aspect is quite evident, that much conjecture is required in this form of survey. This is not specific to quantitative approaches, as all forms of archaeological reconstruction are somewhat speculative in nature. However, the nature of this survey requires the measuring of conjecture. Transparency is thus key, the assumptions can be tested, refuted or refined. The quantitative process not only promotes a deep understanding of the structure, but also has a surprising resonance with the ancient world. This makes the quantitative approach, warts, conjecture and all, worthwhile. As a

[111] Wheatley & Gillings, 2002, 203-4; Lock, 2003, 175-6.

reference point Table 4.10 shows the values used throughout the quantitative process.

Table 4.10		
Variable	Description	Value
Wall height	The height of the curtain wall.	4m
Fort height	The height of fort walls.	4.2m
MC height	The height of milecastle walls.	4.37m
Turret ground height	The wall height of turrets' ground floors.	4.4m
Type I turret	The total height of a Type I turret.	10.2m
Type II turret	The total height of a Type II turret.	11.7m
Type III turret	The total height of a Type III turret.	13.2m
Door height	The height of turret doorways.	1.778m
Average door width	The average width of turret doorways.	1.02m
Archway height	The height of archways in milecastles and forts.	3.55m
Type I turf	Top width of turf ramparts.	1.8m
Type II turf	Top width of turf ramparts.	3m
Mound height	The height of the Vallum mounds.	1.22m
Substructure 1	Volume of timber, per m^3 of turf, in the substructure of a Type I turf structure.	0.00056m^3
Substructure 2	Volume of timber, per m^3 of turf, in the substructure of a Type II turf structure.	0.00088m^3
Parapet	Volume of timber, per m^3 of turf, in the parapet of a turf structure.	0.065m^3
Access 1	Volume of timber per access way made from 15cm x 15cm poles.	1.66m^3
Walk Split Pole 1	Volume of timber per m^3 of turf in the rampart walk, made with 10cm x 5cm split poles, on a Type I turf structure.	0.07m^3
Walk Split Pole 2	Volume of timber per m^3 of turf in the rampart walk, made with 10cm x 5cm split poles, on a Type II turf structure.	0.12m^3

Table 4.10: Summary of variables used in quantitative survey.

Table 4.11: Wall chronology used in study.

Gateway Double	The volume of timber in a double portal gateway, including two towers.	32.9m^3
Gateway Single	The volume of timber in a single portal gateway, including one tower.	21.2m^3
Building Season	The number of days per year in which building work could take place.	200 days
Agricultural Season	The number of days per year in which agricultural work could take place.	250 days
Working Day	The length of the working day.	8 hours.
Work Area	Space, per person, to maintain efficient work.	14m^2
Haulage High	Volume of stone hauled per person day.	2.5m^3
Stonework Low	Volume of stone worked per person day.	5m^3
Mortared Stonework	Volume of mortared stone worked per person day.	0.25m^3
Shaping	Volume of stone shaped on site per person day.	0.8m^3
Turf Cutting	Number of turves cut per person day.	44 turves
Turf Haulage	Number of turves hauled per person day.	216.36 turves
Turf Laying	Number of turves cut per person day.	44 turves
Ditch Excavation	Volume of ditch cut per person day.	8m^3
Parapet Work	Days worked per m^3 of parapet volume (includes substructure).	4.44 days
Split Pole Work	Days worked per m^3 of split pole volume.	5.9 days
Gateway Double Work	Days worked per m^3 of double gateway volume.	2.73 days
Gateway Single Work	Days worked per m^3 of single gateway volume.	2.9 days
Access Work	Person days required per access way.	85 days
'Inchtuthil Ratio'	Percentage of fort comprised by walls, gateways and towers.	14%
Timber Barrack Volume	Volume of timber per barrack block.	120m^3
Timber Barrack Work	Number of person days required per timber barrack block.	1,170.92 person days
Stone Barrack, Stone Volume	Volume of stone per stone barrack block.	312.60m^3

Stone Barrack, Timber Volume	Volume of timber per stone barrack block.	72.27m^3
Stone Barrack, Stone Work	Number of person days required for the stone in a stone barrack block.	1,091.90 person days
Stone Barrack, Timber Work	Number of person days required for the timber in a stone barrack block.	531.70 person days
Labour Cost	Cost of labour per person day.	£120
Supervision Cost	Cost of supervision per person day.	£12
Turf Cost	Cost of turf per m^3.	£40
Timber Cost	Cost of timber per m^3.	£150
Stone Cost	Cost of stone per m^3.	£500
Equipment Cost	Cost of equipment per person day.	£10
Scaffold Cost	Cost of scaffold per person day.	£20
Calories	Number of calories needed per person day.	3,240 calories

Finally, the following chronology will be used throughout:

Table 4.11

Year	Stone Wall	Turf Wall	Cumbrian Coast	Forts	Vallum
122	MC4-MC7				
123	MC7-MC22	MC49-T64b(?)	T80b-MF20(?)	Outpost forts planned (commenced?)	
124	MC22-T27a T36b-Irthing	MC65-T80a(?)	MF20-MF40(?)		
Dislocation by Fort Decision					
	Remaining Structures T27b-Irthing	Continuing (?)	Continuing (?)	Primary forts commenced	Commenced
125	Continuing			Continuing	Continuing

Table 4.11					
126	Reduction in gauge of curtain (?) continuing work on MC22-Irthing			Continuing	Continuing
Governorship of Platorius Nepos Ended (?)					
127	Continuing/ extension to Wallsend			Continuing	Continuing (?)
128-38	Completion of curtain/extension to Wallsend	Rebuilding in stone commenced		Completion of primary forts, Carrawburgh added, Cumbrian forts completed, Outpost forts completed (by *c*.130?)	
136-7				Carvoran rebuilt in stone	

V | The Stanegate

It seems likely that somewhere about A.D. 90 the limes *of the Roman province was withdrawn to a line which nearly coincided with the line subsequently chosen for Hadrian's Wall, and that this new* limes *was protected by some sort of* praetentura*, consisting in all probability of a number of fortified posts.*

FORSTER & KNOWLES, 1915, 268.

§ 5.1 | Introduction

The Stanegate is the name given the series of sites which run between Corbridge in the east, and Carlisle in the west. The Roman name is lost, the term 'Stanegate', meaning 'stone road' is the mediaeval name given to the road which connects these two forts and the intervening sites.[1] The Stanegate and its installations pre-date the Wall, and they are located along roughly the same course. Some of the Stanegate's installations are integrated into Hadrian's Wall.

The aims of this thesis include both an analysis of the functional bias and the reassessment of various models for understanding the Wall. The Stanegate is important for understanding the Wall as it is often interpreted as a pre-Hadrianic frontier. Conventionally, this frontier is inadequate in the defence of the province, and is thus superseded by Hadrian's Wall. However, the Stanegate appears to be involved in a recursive relationship with the Wall, where the Hadrianic structure is used to inform the extent and function of the Stanegate. This, in turn, is reflected back onto Hadrian's Wall as evidence for a long standing requirement for a defensive frontier system. This chapter will therefore examine prevalent Stanegate theories, and observe their influences which are both retrojected and projected

[1] Breeze, 2006b, 50.

from and onto the Wall. Are our Stanegate models a reflexion of the role the structures played in the Roman era, or do they say more about the Wall itself and our assumption of similarity of purpose across time? This chapter focuses on what this can reveal about the origins and the intentionality behind the Wall.

§ 5.2 | Schedule of Sites

Rather than simply defining a geographical study area, the schedule of Stanegate sites is intimately connected to the study of 'system'. Scholars who presume the most Wall-like system tend to see the Stanegate as a comprehensive series of sites stretching from the east coast to the Solway: contrasting 'minimising' approaches to the Stanegate include fewer sites as part of the 'system'. Nick Hodgson's *The Stanegate: A Frontier Rehabilitated*, published in 2000, includes the sites of Washing Well, Ebchester and *Arbeia* in South Shields; extending the Stanegate to the east coast. The western system incorporates Kirkbride and Burgh-by-Sands, creating a model with a broad linear distribution of sites similar to the Wall. The paper's title leaves little doubt as to the aim of the study: finding a pre-Hadrianic frontier on the Tyne-Solway axis, and thus an antecedent of the Wall. Hodgson's sites are included here as the 'extended' group alongside the 'traditional' sites originally defined by Eric Birley.[2] These are shown on Figure 5.1:

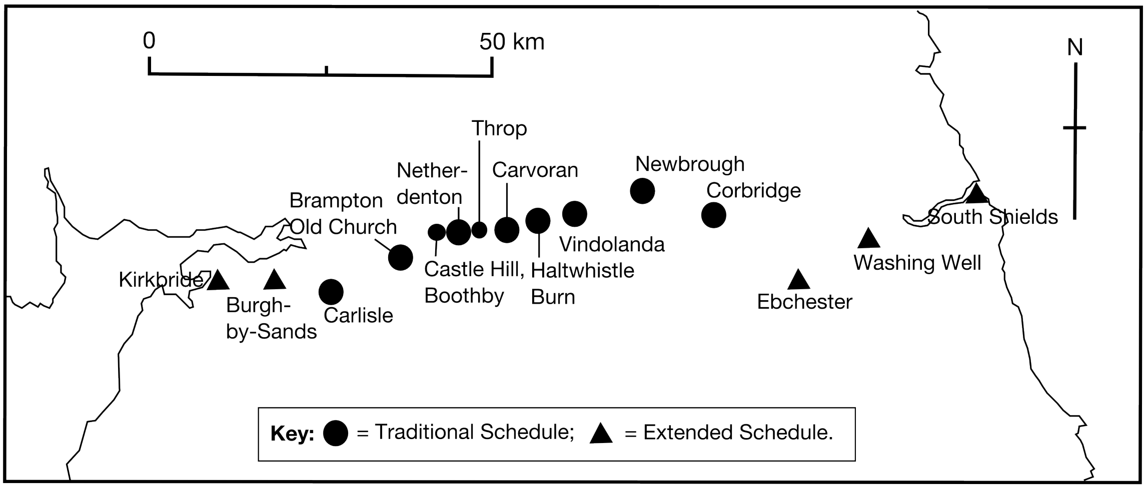

Fig. 5.1: Map of Stanegate sites.

[2] Birley, 1961, 135.

This map clearly demonstrates the contrast between the centrally located traditional schedule and the cross-isthmus extended version supported by Hodgson, emphasising this interpretation's similarity to the Wall. Table 5.1, shows, from east to west, the distances between the main fort sites of both suggested schedules:

Table 5.1		
Traditional	Extended	Distance to Next Site
	South Shields	16 km
	Washing Well	12 km
	Ebchester	15 km
Corbridge		12 km
Newbrough		10 km
Vindolanda		6 km
Haltwhistle Burn		5 km
Carvoran		3 km
Throp		4 km
Nether Denton		5 km
Castle Hill, Boothby		4 km
Brampton Old Church		12 km
Carlisle		7 km
	Burgh-by-Sands	10 km
	Kirkbride	------

Table 5.1: Forts and spacing on the Stanegate.

The forts are not the only Roman military installations on the Stanegate road. There are numerous signal towers which dot the landscape, especially the well-preserved central 29km section between Vindolanda and Brampton Old Church. The inclusion of signal towers is important as it affects both the conceptualisation and examination of the structure. Towers form the core of defining frontiers in other areas: they appear on the Wall, its Antonine successor and the earlier Gask Ridge. Their presence is seen to refer to a 'system' of control, a frontier; though their lack of systematic appearence is often a criticism of the Stanegate as 'proto-Wall'.[3] The main tower sites of the Stanegate are shown in Table 5.2, running east to west:

Table 5.2		
Site	Location	OS Grid Ref
Torney's Fell	Between Corbridge and Newbrough	NY 8663770765
Barcombe Hill	Between Newbrough and Vindolanda	NY 776662
Barcombe Hill B	Between Newbrough and Vindolanda	NY 773657
Mains Rigg	Between Throp and Nether Denton	NY 61326517
Pike Hill	Between Nether Denton and Boothby	NY 5756764807
Nr. Kirkandrews	Between Carlisle and Burgh-by-Sands	NY 350585
Monkhill	Between Carlisle and Burgh-by-Sands	NY 344582
Farhill	Between Burgh-by-Sands and Kirkbride	NY 302582
Easton	Between Burgh-by-Sands and Kirkbride	NY 278579
Fingland Rig	Between Burgh-by-Sands and Kirkbride	NY 2657

Table 5.2: Stanegate signal stations/towers.

§ 5.3 | Traditional Models

In his Seventh Horsley Lecture, Dobson states that 'the thought [of dividing Roman from Barbarian] was hardly alien to the 2nd century'.[4] The same paper proposes a 'minimalist' approach to the Stanegate,[5] yet his discussion of the Stanegate before the Wall betrays how many see the Stanegate, as a direct antecedent for Hadrian's Wall. That one should seek the roots of the structure's design in the same geographic location is hardly surprising given the Wall's unique structure in the Roman world at the time of its completion.

As will be seen, this pre-occupation with the Stanegate's role as Wall progenitor has essentially resulted in working backwards from the

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[3] Dobson, 1986, 4; Hodgson, 2000, 13.

[4] Dobson, 1986, 5. Also, note the use of the *SHA*'s famous quotation as supportive evidence. See Historiography chapter for more on this.

[5] Dobson, 1986, 2-5.

Wall, where the role and function that is presumed for the Wall is retrojected back onto the Stanegate. Consequently lax application of the terms '*limes*' and 'frontier' to the Wall are equally numerous for the Stanegate.[6] However, the definition of the term *limes* in the 1st and 2nd centuries is contrary to the military interpretations of both these structures.[7] From where does this idea of the Stanegate as a form-and-function ancestor of the Wall originate?

The concept of a Trajanic military '*limes*', in the modern use of the word, can be traced back to the era of the Great War. The quotation which opens this chapter is taken from Forster and Knowles' analysis of the 1914 excavations at Corbridge, this demonstrated their belief in the possibility of a pre-Hadrianic *limes*. However, it must be noted that Forster and Knowles were theorising, and went to great lengths to stress the conjectural nature of their discussion due to the incomplete nature of the system they defined:[8]

> If similar should in the future be found at one or more of the five last-mentioned places, it will become probable that the road known as the Stanegate or Carel-gate formed the line which connected the forts of this early frontier, and in that case we might suspect the existence of an undiscovered station at or near Newbrough or Fourstones, while there is a possibility of early sites being proved between Corbridge

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[6] The most recent works on the Stanegate all make note of this: Jones, 1991, 96, 107; Hodgson, 2000, *passim*; Woolliscroft, 2001, 58.

[7] Isaac, 1988, *passim*. There are numerous problems with applying the word *limes* to the Roman military works on the Tyne-Solway isthmus. First and foremost is its connexion to roads, not borders or frontier defences (127); that borders need not be defined by structures and linear barriers (128); that Hadrian's Wall itself is only referred to as *vallum*, and not *limes*; and that there is seemingly no latin term to indicate a defended border (146).
' […] even when using the term [*limes*] to mean 'boundary', none of the sources discussed speaks of it as something constructed or laid out. Where it is stated that the *limes* was 'made', the term is used in the sense of a military road.' *Ibid*, 130.
This creates an interesting point: the Stanegate, undoubtedly, conforms to this Roman description of a *limes*. In which case it could be said that the Stanegate is not a *limes* in that it does not adhere to the modern interpretation and use of the word; however, it is a Roman *limes* of the type commensurate with the use of the word in the 2nd century A.D.

[8] Forster & Knowles, 1915, 268-9.

> and the sea. This theory, however, is stated as a theory only, and to some extent as a suggestion of places where excavation might be usefully carried out.

At this point the putative frontier remains just that. However, the systematic nature of the Wall's form along the line of the isthmus is taken as a key component of a frontier and thus in need of 'discovery' in order to prove or disprove the hypothesis.

Collingwood, in 1937, gave definite form to the idea of the Stanegate as a frontier, as well as its role as Wall progenitor. Citing the road itself as a consequence of Agricola's campaigns, the 'systematic fortification' he attributes directly to Trajan.[9] Here the Stanegate's 'system' and categorisation as a *limes* is leant the appearance of fact even though the arrangements east of the North Tyne are an unknown. Indeed, such is the security with which Hadrian's Wall and the Stanegate are aligned, the link is made explicit:[10]

> On the Tyne-Solway there are three things, each of which might be regarded as in some sense a *limes*. There is Hadrian's Wall, with its forts, milecastles, and turrets, and the military way running close behind it. There is the earthwork which English antiquaries call the Vallum, following the same line a little way south of the Wall. And there is the Stanegate, a fortified road a little way farther south again.

Importantly, this discussion of the Stanegate takes place in a chapter entitled 'The Making of a Frontier'. The Stanegate's role as direct antecedent of the Wall, almost identical in location, and similar in form, is quite clear in this interpretation.

Finally, Birley, in 1961, further adds to the systematic aspects which are an important characteristic of a frontier: forts are claimed to

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[9] Collingwood & Myres, 1937, 127.
[10] Collingwood & Myres, 1937, 124.

alternate with fortlets in a manner reminiscent of milecastles and towers on the Wall itself.[11] East of Vindolanda, however, Birley's rigid alternation of forts and fortlets falters due to a lack of known sites. Similarly, with the anatomy of the Wall informing the structural aspects of a frontier, Birley hypothesised that 'other towers presumably await discovery further east',[12] towers which would provide further systematic proof to the frontier concept. Despite these shortcomings, the Trajanic *limes* based on the Stanegate appeared to have reached widespread acceptance.

However, since the 1970s, the idea of the Stanegate frontier has been exposed to repeated criticism. Daniels, in 1970, wrote 'that not only is the date of many of [the Stanegate's] components weak, but its overall existence as a regular system is barely stronger'.[13] Again, systematisation appears to be the key aspect to a military frontier. Similarly, Dobson's seventh Horsley Lecture concludes that the lack of half-day forts and regular towers seriously harms the Stanegate's case as a frontier in its own right.[14]

Importantly, though, the prime facet in analysis from the dawn of the Great War through to end of the 20th century, the requirement of regular, systematic, recurring forts and towers, owes its prominence not to the Stanegate, but to the Wall. In a circular relationship similar to that seen with the use of historical sources and Wall-studies,[15] Birley's inspiration for systematic half-day forts refers back to Hadrian's Wall. The German scholar Fabricius had suggested just such an arrangement in the Taunus mountains in 1935, this proposition was doubtless influenced by the systematic placement

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[11] Birley, 1961, 134.

[12] Birley, 1961, 135. Note, on Table 5.1 the comparatively large distances between the eastern sites of the extended schedule compared to the smaller distances of the traditional model. This emphasis on further sites in the east, though none have been forthcoming, is to stop the comparative disjointedness of this section from detracting form the argument for a Wall-like sealing of the isthmus.

[13] Daniels, 1970, 94.

[14] Dobson, 1986, 4-5.

[15] See Chapter 2, Historiography and the Wall.

of structures on Hadrian's Wall.[16] Consequently, in using Fabricius' work, Hadrian's Wall was reflected through two layers of interpretation before its application to Stanegate anatomy.

Whilst both Daniels and Dobson seek to minimise the extent of the 'system', their language still has numerous references to the idea of a 'frontier'[17] and a search for 'system'.[18] Even though Dobson concludes that there is little evidence for a Stanegate frontier in the style of Hadrian's Wall, he is, in effect, searching for the origins of the Wall. This says far more about the Wall's form than that of the structures along the Stanegate road.

§ 5.4 | Current Models

Despite a lack of system implying that the Stanegate was not a frontier, the idea persists. The fact that systematic installations do not exist on the Stanegate has meant that a more ad hoc understanding of frontiers has been developed. As Jones stated: '[a lack of a rigid system of installations] does not preclude some cohesive arrangement, or more probably arrangements, did not exist at varying times.'[19] Jones is quite clear in his analysis that this system comprises a *limes* – an early stage of 'limitane development prior to the erection of Hadrian's Wall.'[20] His ad hoc frontier *limes* is connected to the geography of the area, organised not along lines of major 'outpost forts',[21] but on the Tyne-Solway isthmus itself. Location is key as this shows a working backwards from the Wall, reverse engineering its function and finding evidence in the area.

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[16] Fabricius, 1935, 38-40; *id*. 1936ab; Hodgson, 2000, 20.

[17] Dobson defines a frontier as: 'a disposition of forces along the frontier line in a greater concentration than elsewhere, with sometimes the addition of observation posts (towers) and fortlets accommodating small groups of men.' 1986, 2-3. The similarities between the form of the Wall and this definition is both striking and undoubted.

[18] Dobson, 1986, 4-5.

[19] Jones, 1991, 99.

[20] Jones, 1991, 107.

[21] It is debatable what these 'outposts' actually are, as, in the period where the Stanegate system is considered to begin developing there are unequivocally Roman soldiers north of the Tyne-Solway axis.

Dobson, as noted, considers the Stanegate in a self-confessed 'minimalist' manner,[22] though terms like 'system' and 'frontier' are used throughout his analysis. In his interpretation, a low level organisation based around the Stanegate road and having Corbridge, the lowest bridging point of the Tyne, controlling access in the east, was developed. This coalesces into a more standard frontier with the withdrawal of Roman soldiery from lowland Scotland. The Stanegate, in this model, is depicted as a series of reactions related to local problems culminating in a system strung out along the Tyne-Solway isthmus.[23] The language and the theory itself is quite clear, that whilst there is no overarching design, aim and intention of creating a frontier based around the Stanegate, just such a structure evolves over time.

Can the theory of 'organic' evolution of frontiers illuminate the origins of the Stanegate, and thus the Wall? First and foremost, the existence of the road creates issues. Jones conflates the road and fort combination as being indicative of a frontier: 'Thus at Vindolanda, the paradigm for pre-Hadrianic arrangements, a large fort along an arterial road, has been established for some time through excavation.'[24] However, such a set-up is commonplace right across the empire, thus it cannot be used as a herald of frontier development. This can be seen on Figure 5.2 which shows the number of the forts along the line of the Stanegate in A.D. 85, when compared with the parallel road on the Stainmore Gap.

As can be seen, the Stainmore Gap has more installations at this time, six compared to the Stanegate's four. The Stanegate evolves to introduce Brampton between Nether Denton and Carlisle, and Carvoran between Vindolanda and Nether Denton, bringing the total up to six by A.D. 110. At the same time on Stainmore, Carkin Moor has fallen into disuse, but has been replaced by a fort at Greta

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[22] Dobson, 1986, 5.
[23] Dobson, 1986, 4-5.
[24] Jones, 1991, 99.

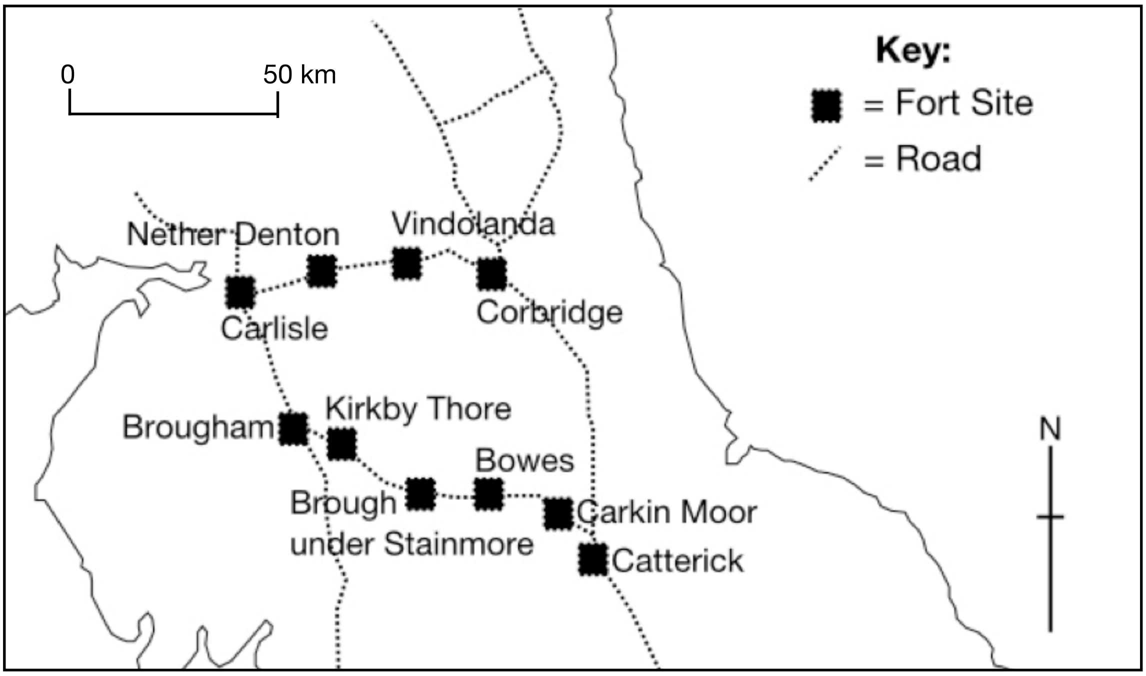

Fig. 5.2: Installations on the Stainmore Gap compared with the Stanegate in A.D.85.

Bridge.[25] Thus the total number of forts on the Stanegate never exceeds the total on the Stainmore Gap line. Furthermore, Stainmore also has towers. This has particular resonance for Jones' model, as it begs the question as to why no one has associated Stainmore with frontier status given that it meets the 'fort and road' criterion and possess towers. Thus the existence of towers and a road hand-in-hand with forts, given their regular occurrence in the Roman world, should not be seen as a prima facie indicator of a 'system', '*limes*', 'frontier' or even a 'defended road'.

Dobson's minimalist understanding of the Stanegate, with its ad hoc approach, needs further examination. The withdrawal of soldiery from the lowlands is considered demonstrative of the need for a frontier. There is little evidence as to the nature of the problems that prompted the reorganisation of the forts and fortlets along the Stanegate road. Furthermore, the soldiers are transferred to fight in Trajan's continental wars, their withdrawal is not due to military defeat resulting in a need for better defensive positions. The Vindolanda tablets further reinforce this image of a broadly peaceful area of the Roman Empire; they are silent on the subject of military

[25] Dobson, 1985, Fig. 4.

difficulties in the area.[26] The situation north of the Stanegate line is important for many models of frontier development. Without a threat to the north, and there is still not a secure example of such, where is the impetus for forming a defensive frontier?

The Wall's existence, form and purpose permeates the study of the Stanegate. Despite the lack of similar archaeology and system, the core concept of the Stanegate as a Wall antecedent remains. The search for Wall-like structures and systems has simply been replaced by a concomitant purpose between Wall and Stanegate: a defended frontier. This is distilled in Breeze's summary of the subject: 'It was perhaps recognition of the failure of existing arrangements on the isthmus which led to the construction of the Wall.'[27] The Stanegate is seen, through this need for Wall antecedents, to be a failed system in the same geographic location in need of replacement. In this manner a proto-Wall is found.

§ 5.4.1 | The Rehabilitated Frontier

Hodgson's aforementioned paper, 'The Stanegate: A Frontier Rehabilitated', is the most recent restatement of the case for a bona fide frontier. As noted in the schedule of sites, this model includes more eastern and western installations thus giving the Stanegate complete control of the Tyne-Solway axis. This model seeks to counter the erosive process resulting from the minimalist, ad hoc, organic systems outlined by Jones and Dobson. Dobson's critique that a lack of continuous tower/turret cordon would preclude a Trajanic frontier as a Wall antecedent[28] is tackled through a comparative study with the Germanic frontier.[29] With no troop dispositions beyond the Taunas and northern Wetterau these are taken as clear frontiers. Both of these areas show no such

[26] Hodgson, 2000, 12.
[27] Breeze, 2006b, 50.
[28] Dobson, 1986, 2-5.
[29] Interestingly this connects to a tradition of study of Hadrian's Wall whereby the 'frontier' works of Britain and Germany are used as recursive influences. This has already been seen to occur on the Stanegate, supra, §5.3. See James, 2002, 16.

deployment of a cordon, and this is used to justify the existence of a frontier without such a feature.[30]

The problem of the road's existence, which lends weight to the interpretation of the Stanegate as either a defended or normal road,[31] is cast aside as a 'red herring'.[32] This relies on a chronological interpretation of the installations predating the road's construction, with the Stanegate built later to connect the sites which are placed according to frontier defence.[33] Hodgson does concede that the metalled surface was most likely a Roman intervention, and in the case of Throp a realignment, of a pre-existing surface.[34]

The silence of the Vindolanda tablets on the subject of military action is not, however, a problem for Hodgson's model. At the time the tablets were written troops were still widely disposed north of the Tyne-Solway line, this purportedly changes after the withdrawal of *c*.A.D.105 for Trajan's continental wars. Hodgson thus attributes the Stanegate's frontier role to the post *c*.A.D.105 period, and models the Stanegate on the contemporary cordon-less German installations. This model seems compelling: it liberates the sites from an over-reliance on the road, accounts for the need for a frontier by the withdrawal of units, and uses contemporary examples for the the Stanegate's form, which is different from the Wall's.

However, in unifying all the installations along the axis of the two rivers, the search for a frontier struggles. Hodgson says: 'The suggestion that an arterial route or road might not be primary to the 'Stanegate system' combines with the evidence of the continental parallels to return us to the traditional view that the Stanegate sites

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30 Hodgson, 2000, 13-6.
31 As demonstrated on Fig. 5.2, above.
32 Hodgson, 2000, 18.
33 Poulter, 1998, *passim*; Hodgson, 2000, 16-7.
34 Hodgson, 2000, 17.

represent a frontier line, or a proto-frontier line.'[35] The inclusion of installations to the east of Corbridge and west of Carlisle, with no connexion by road or signal to the sites on the Stanegate road, renders frontier control difficult, especially as Hodgson sees it as a key facet.[36] This lack of uniformity harks back to Dobson's minimalist interpretation, supra, with ad hoc localised developments governing the installations, and not an overarching 'Stanegate system'. Whilst this does not necessarily preclude area, rather than frontier, control as a reason for the existence of these installations, it does call into question the intentionality of creating a frontier as well as seeing the Stanegate as a Wall antecedent.

Furthermore, despite the argument laid out by Hodgson regarding the silence of the Vindolanda tablets, this interpretation still does not account for the nature of the withdrawal: a voluntary movement to meet demands in other parts of the empire.[37] Perhaps the most difficult question for this type of model is: if Hadrian's Wall represents a solidifying of a frontier due to security, why do the Stanegate sites remain in occupation? This question is all the more pressing given the decision to move forts onto the line of the Wall in *c*.A.D.124. The evidence for continued occupation on the Stanegate sites is summarised below for the central, most frontier-like, section between Vindolanda and Brampton Old Church:[38]

> *Vindolanda*: the building of Hadrian's Wall appears to coincide with the removal of the First Cohort of Tungrians, with attachments of Vardullians and legionaries, and their replacement by the Third Cohort of Nervians in *c*.A.D.120s.

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[35] Hodgson, 2000, 19. Whilst no exact definition of a 'proto-frontier' is given, this would appear to be traditional installations pressed into service as a frontier before the development of frontier-specific structures to meet the exact needs of the line.

[36] Hodgson, 2000, 21.

[37] Interestingly, when Hodgson is discussing the status of the Stanegate pre-*c*.A.D. 105, he sees it as a time of 'faltering advance' in 'an age of troop-withdrawal'. This is tacitly couched in terms of military defeat, for which there is little evidence.

[38] Woolliscroft, 2001, 53-5.

The fort thus remains in use after the construction of the Wall.[39]

Haltwhistle Burn: the fortlet's inception is dated somewhere in the reign of Trajan (A.D.98-117) with finds' evidence detailing a long occupation.[40] It is thus a strong possibility that the fortlet could have remained in use after the construction of Hadrian's Wall.

Throp: exhibits signs of occupation in the 2nd century, though cannot be precisely dated either pre- or post-wall. It must be noted that the sites 4th century re-occupation, and a lack of a formal demolition, as seen at Haltwhistle Burn, lend weight to continued occupation into the Wall period.[41]

Mains Rigg: unknown occupation history, though its association with aiding communication between Throp and Nether Denton[42] would imply occupation on site as long as those which it served.

Nether Denton: pottery dates at this site indicate occupation into the late-2nd century A.D., this has been seen as indicative of the continuation of the site's civil settlement after the abandonment of the fort. However, it must be noted that this model was developed in a period when it was believed that all the Stanegate sites were abandoned in favour of Hadrian's Wall. Equally likely, however, if not more so given the general continued occupation on the Stanegate sites as a whole and a lack of demolition layers on this site

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[39] Breeze, 2006b, 431-4.
[40] Breeze, 2006b, 448.
[41] Breeze, 2006b, 451.
[42] Breeze, 2006b, 451-2.

in particular, is that the fort continued in use throughout the 2nd century after the construction of the Wall.[43]

Castle Hill Boothby: unknown occupation history.

Brampton Old Church: Abundant pottery finds date the site to the early-2nd century. Both kilns and the fort ceased activity with the unit's transfer to Hadrian's Wall. A demolition layer is also present on this site.[44]

As the above summation shows, only one site, that of Brampton Old Church, can be seen to have definitely been abandoned with the construction of the Wall. Other sites, like Haltwhistle Burn, are, on the balance of probabilities, more likely to have remained in occupation. Perhaps most interesting is that sites such as Throp, a fortlet which should be vulnerable to any form of reorganisation given the small unit size,[45] remains in use. This is a major hurdle for theories of function which seek to establish the Stanegate as the Wall's progenitor.

This lack of abandonment poses a number of consequences for the Stanegate. Although both the Stanegate and Wall are purportedly a response to the same issues, the difference in design between the two means that the latter would completely supersede the former. Thus there should be a significant alteration in occupation on the Stanegate if it was a failed mono-causal frontier control mechanism. Importantly, the widely accepted fact that the Stanegate and the Wall are divergent means, quite simply, that the Wall does not have a direct antecedent in the area.[46] However, there is one model which

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[43] Breeze, 2006b, 453.

[44] Breeze, 2006b, 455-6.

[45] Of similar size to Haltwhistle Burn and garrisoned by a mere century of men. Breeze, 2006b, 447-8.

[46] As noted by Dobson, 1986, 5: 'if the minimalist view of the "Stanegate system" outlined above is accepted [Hadrian's Wall] had very little in the way of antecedents on the Tyne-Solway line.'

takes continued occupation into account, David Woolliscroft's signalling theory.

§ 5.4.2 | Signalling and the Stanegate

In Woolliscroft's theory, the Stanegate is organised along lines associated with intervisibility for a signalling network. The sites are placed to allow visual signals to be passed between them, relying on intervisibility between sites or, in places where breaks in the 'chain' occur, signal stations to act as relays in the sequence.[47] This system, despite pre-dating Hadrian's Wall, is adopted for the Wall itself upon its construction and includes the Stanegate sites.[48] As a consequence of this integration, the Stanegate sites need not be abandoned. This allows the connexion between the Wall in both a physical and functional way, and promotes Woolliscroft's highly militarised interpretation: 'The Stanegate frontier was essentially an invasion defence depending on large auxiliary unit sized concentrations of force that could be combined to form a single substantial army.'[49]

Opening this theory to critical appraisal uncovers certain aspects of the information used by Woolliscroft which cannot be reconciled. As with the other models for the Wall, the situation to the north, the presence or lack of troop dispositions, causes problems for the model.[50] Whilst Woolliscroft expressly identifies the ad hoc development of a frontier, with responses put in place in order to allow signalling, there is an echo of Dobson's argument of local responses eventually coalescing into a cohesive system. Both theories are susceptible to similar critiques. Whilst Woolliscroft's model does assuage the problem of continuing occupation in the first phase of Wall development, the fort decision would have

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[47] Woolliscroft, 2001, 53-8.
[48] Woolliscroft, 2001, 63-73.
[49] Woolliscroft, 2001, 58.
[50] Supra, §5.4.1.

encouraged the movement of units from the Stanegate onto the line of the Wall were the two integrated in purpose.

§ 5.4.2.1 | Signalling Model Testing

Given the increasing potential of GIS software, digitally testing Woolliscroft's model is now possible. The need to test the claims of Woolliscroft's model is intensified by the debate surrounding the height of Roman towers. Woolliscroft's methodology involved testing the line-of-sight from the location of the installations themselves. This involved the use of a camera on a pole, though the height of the pole itself is never revealed.[51] For the purposes of these tests the norms set out for turret heights, in §4.5.2, are used. The highest value, 13.2m is selected and a standard person viewing height of 1.5m is added, giving a total 'z' value offset of 14.7m. The test area is that of Woolliscroft's,[52] a 28 Wall-mile area from MC30 (Limestone Corner) to MC58 (Irthington). The hard- and software, methodology and theory, is explained in §4.13. Point-to-point visual analysis was performed using the 3D Analyst→Line of Sight function within ArcMap. The resulting line-of-sight viewshed could then be extracted and introduced into ArcScene's 3D model.

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[51] Woolliscroft, 2001, Introduction and Chp.1, also Fig.1, p.17.

[52] Woolliscroft, 2001, 58.

§ 5.4.2.2 | Results

The test moves east to west, and is illustrated in ArcMap and supplemented by ArcScene where appropriate. The line traces the route of line of sight viewshed, areas in red are occluded and cannot be seen, areas in green are visible. For a site to be inter visible, green needs to be present by both points on the line of sight route.

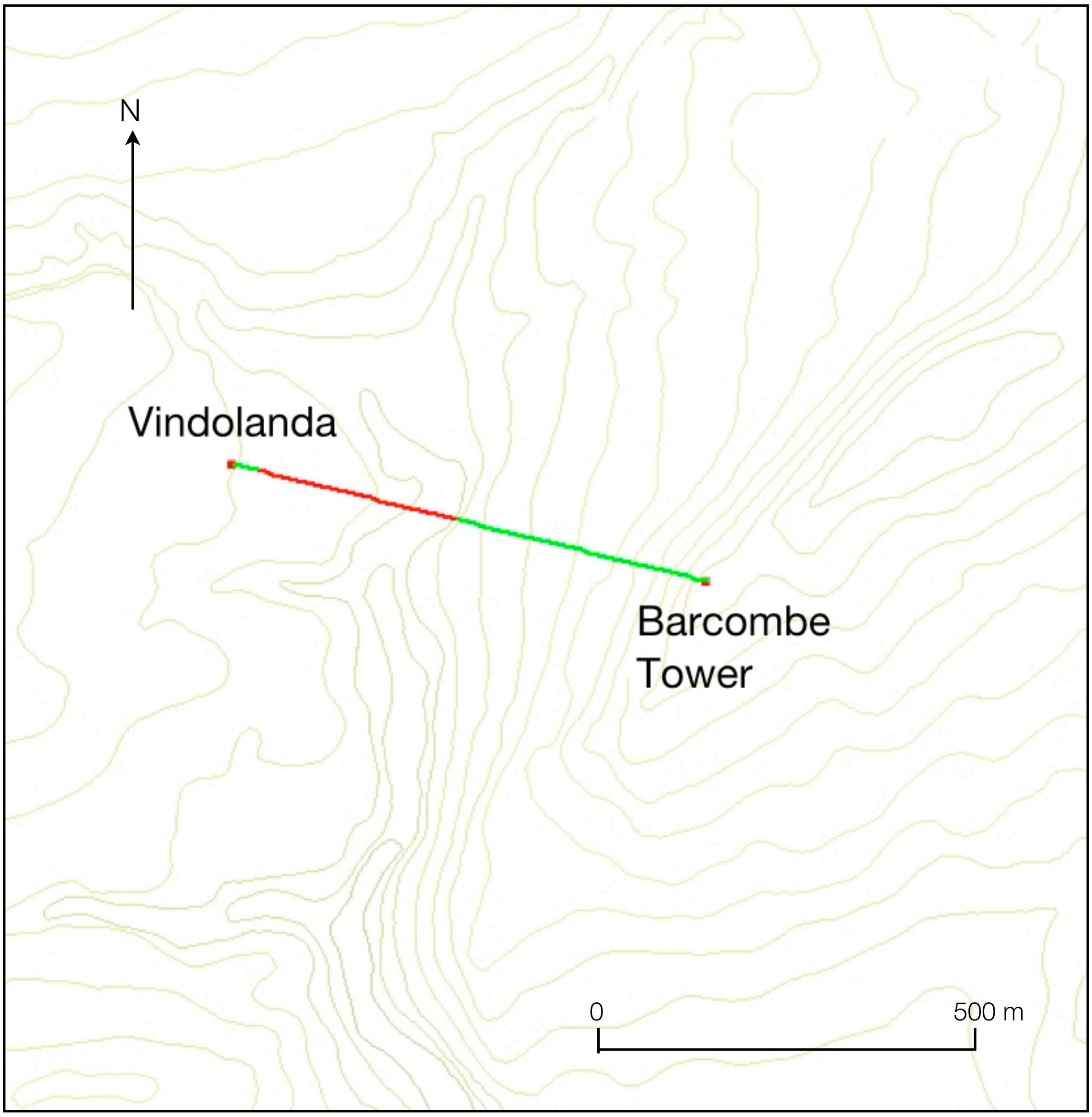

Fig. 5.3: Line of Sight 1, Vindolanda to Barcombe Tower. The green around both Vindolanda and Barcombe Tower show that there is a clear visual relationship between these two sites.

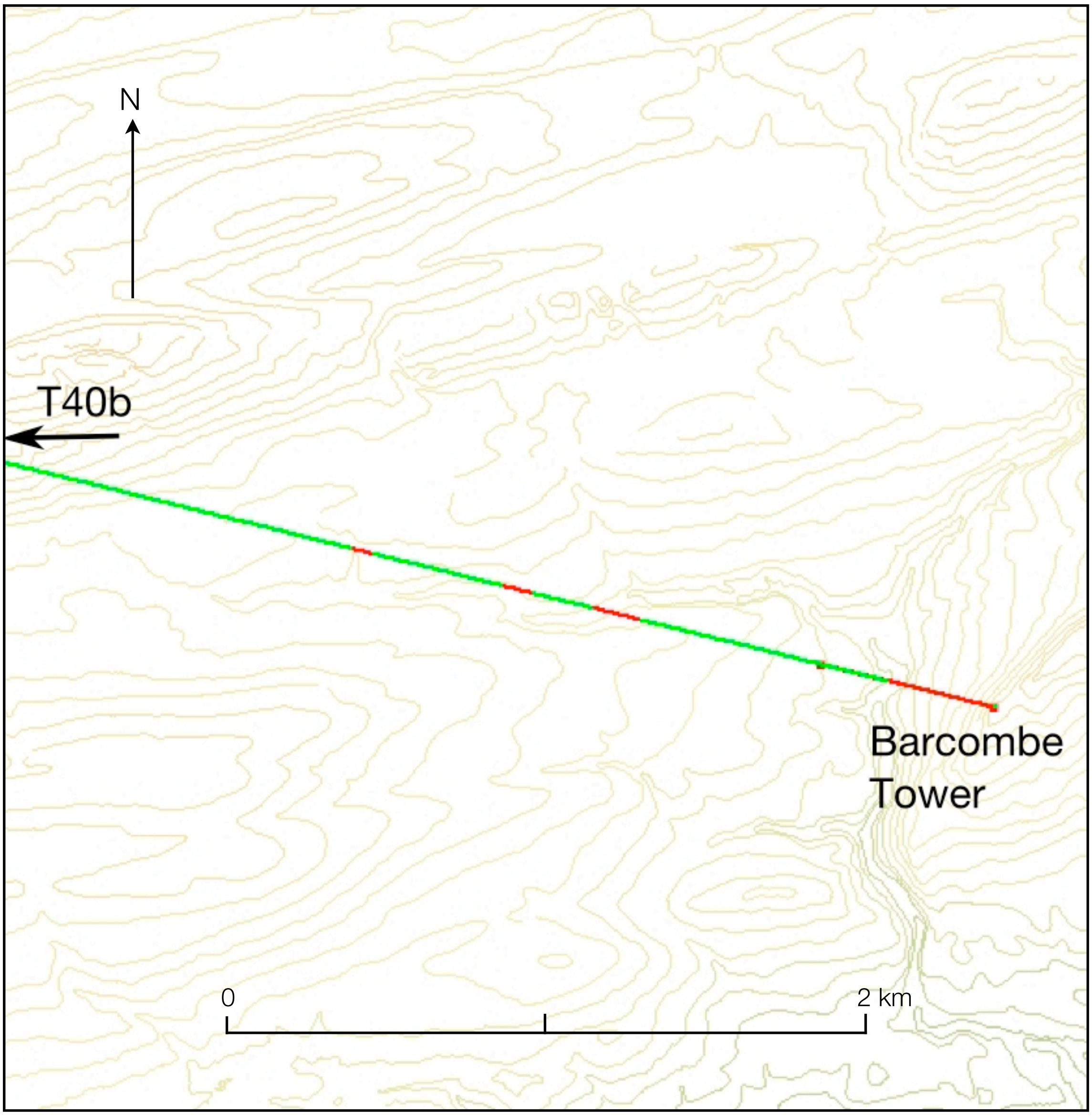

Fig. 5.4: Line of Sight 2, Barcombe to T40b.[53] The line of sight shows that much can be seen clearly. The small amount of green at the Barcombe Tower end, combined with the long green section from T40b eastwards, shows that these sites are theoretically intervisible. Note the one area of occlusion, immediately west of Barcombe, is an area that can be seen on the first viewshed, the two sites combining to give full coverage of the area.

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[53] Note that T40b does not appear on this map due to an imaging error. The line, however, does extend to meet the site and remains green.

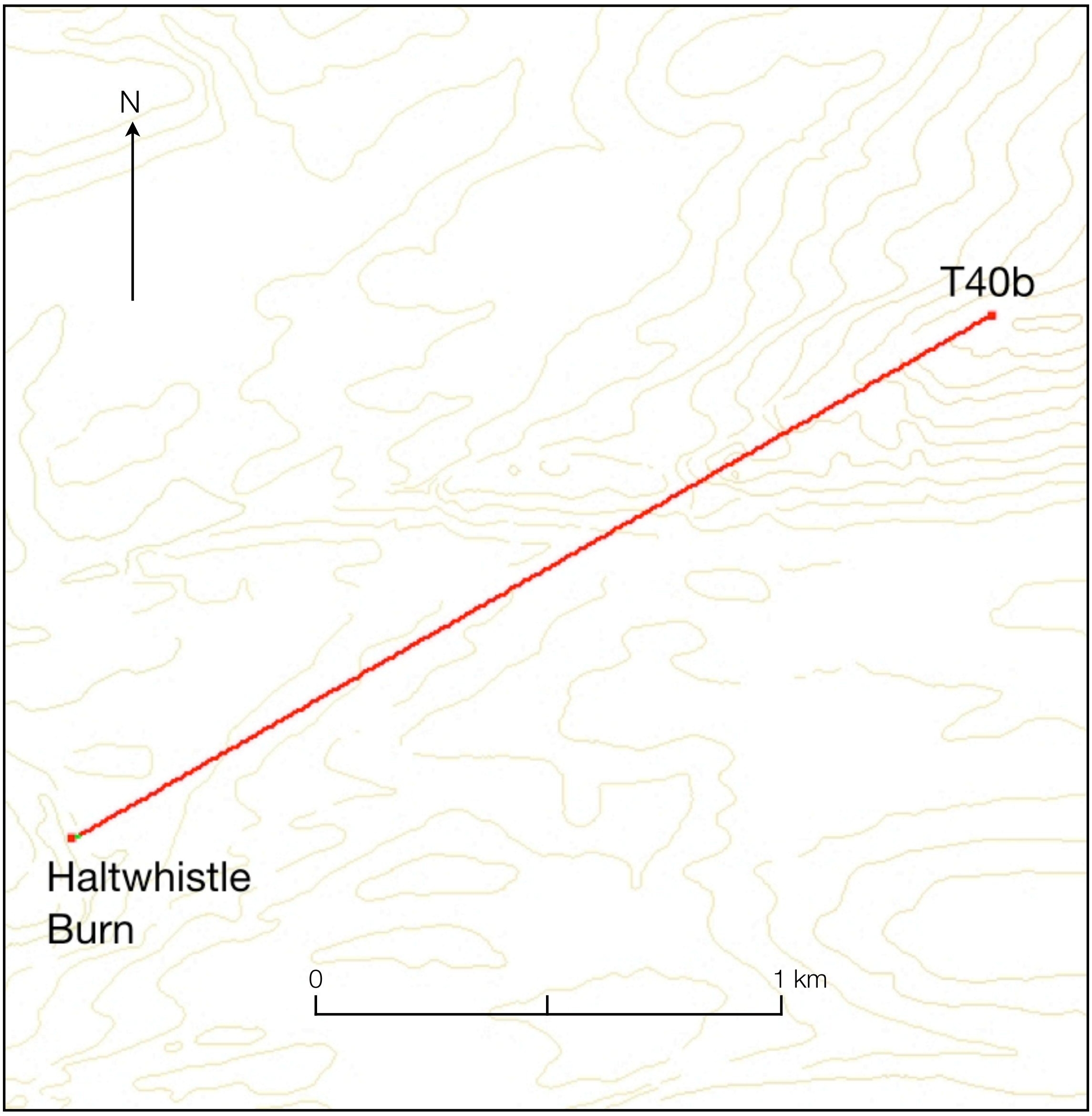

Fig. 5.5: Line of Sight 3, T40b to Haltwhistle Burn. As can be seen, with only a tiny amount of green on the line of sight route, these two installations are theoretically not intervisible. This is contra Woolliscroft who claims intervisibility for these sites.[54]

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[54] Woolliscroft, 2001, 67, Fig.25.

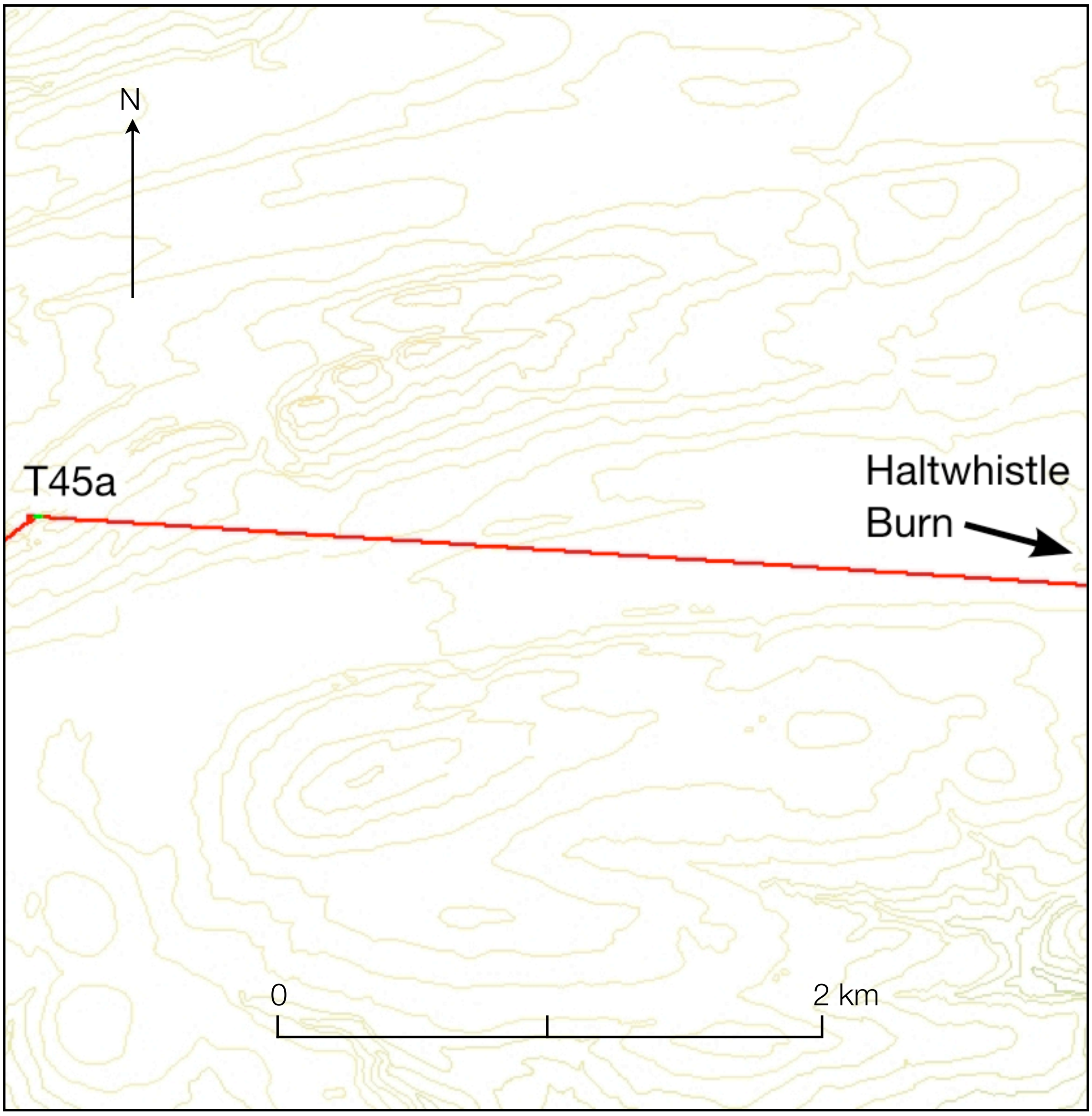


Fig. 5.6: Line of Sight 4, Haltwhistle Burn to T45a.[55] With only a mere hint of green by T45a, these two sites are theoretically not intervisible.

[55] Haltwhistle Burn appears off the image due to the same problems as with viewshed two. The line of sight continues to this fort, and remains red.

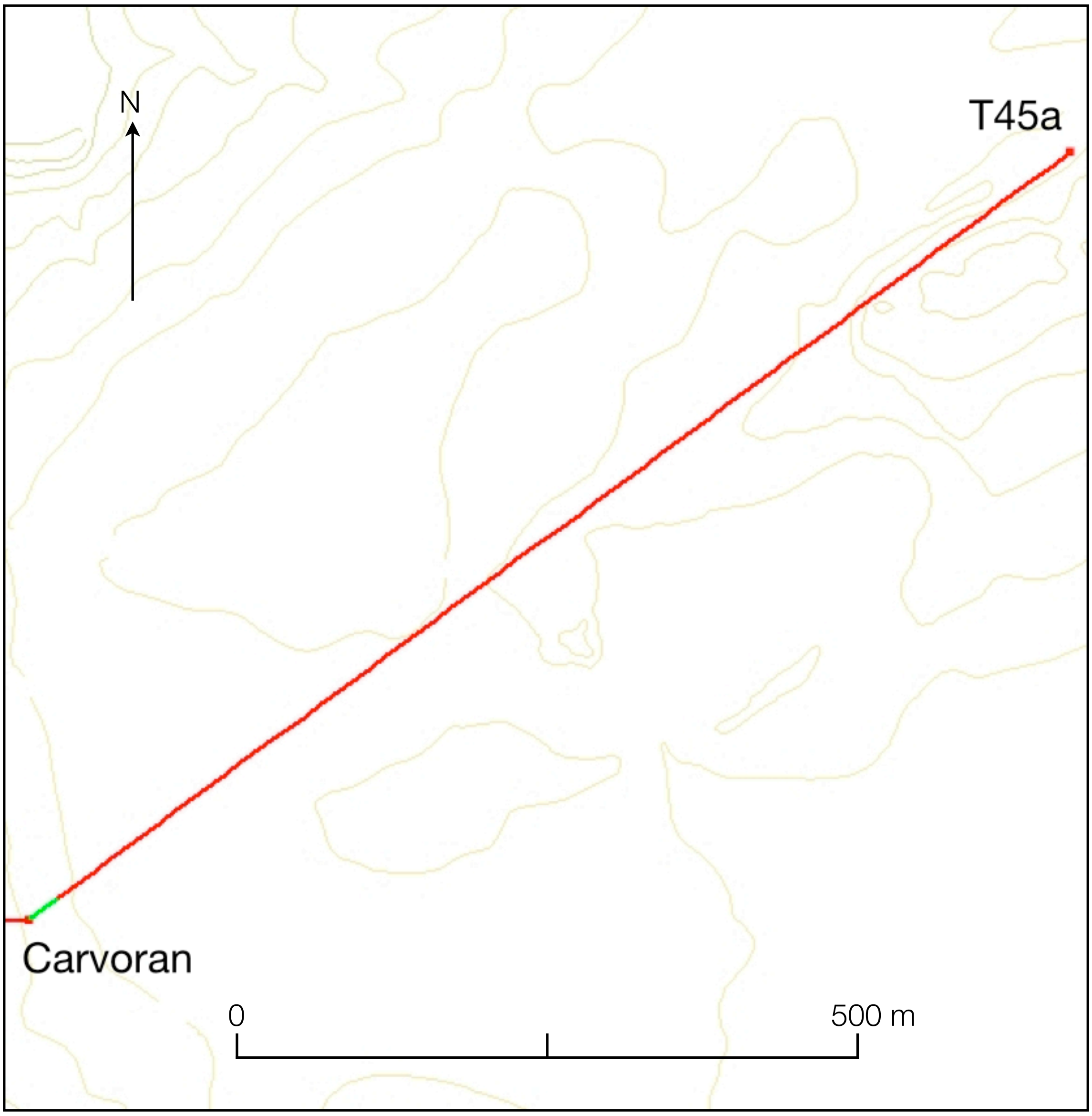


Fig. 5.7: Line of Sight 5, T45a to Carvoran. As with the previous two line of sight analyses, these results show that, with only a small amount of visibility these sites are theoretically dislocated.

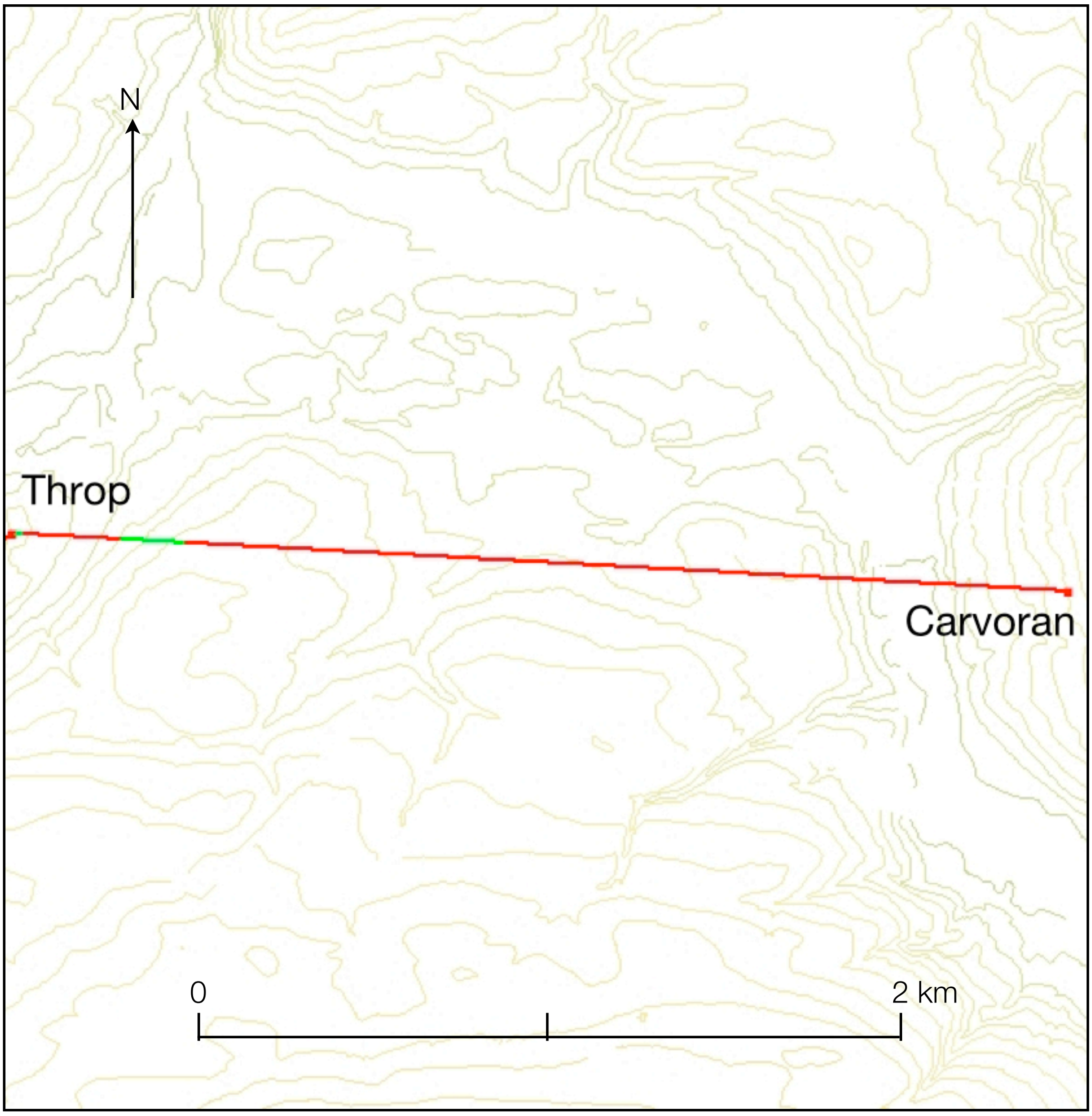


Fig. 5.8: Line of Sight 6, Carvoran to Throp. The now familiar, largely red, line of sight viewshed demonstrates that these two sites are theoretically not intervisible.

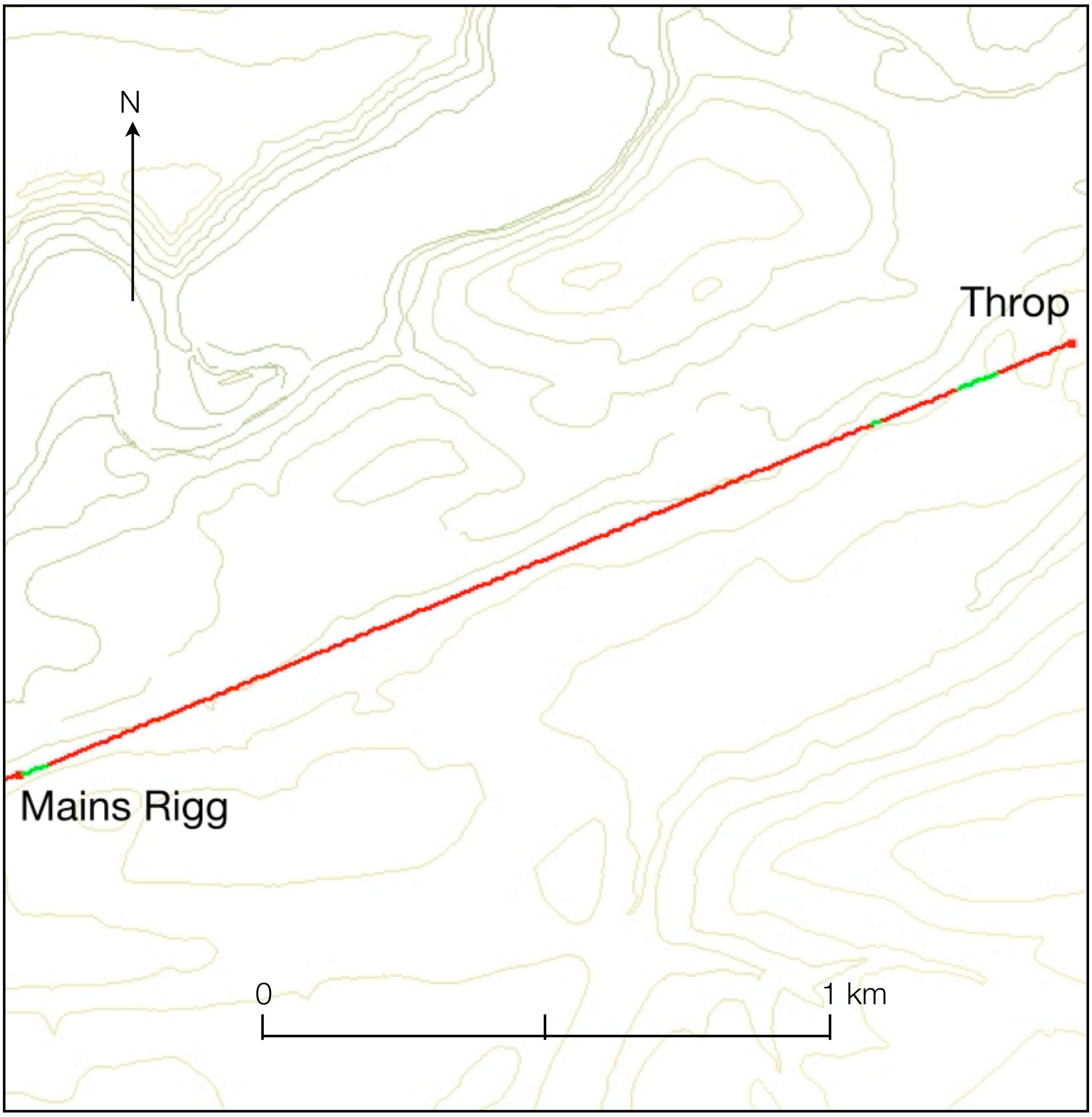


Fig. 5.9: Line of Sight 7, Throp to Mains Rigg. Despite occasional interludes of visible areas along the line of the viewshed, these two sites remain theoretically occluded from one another.

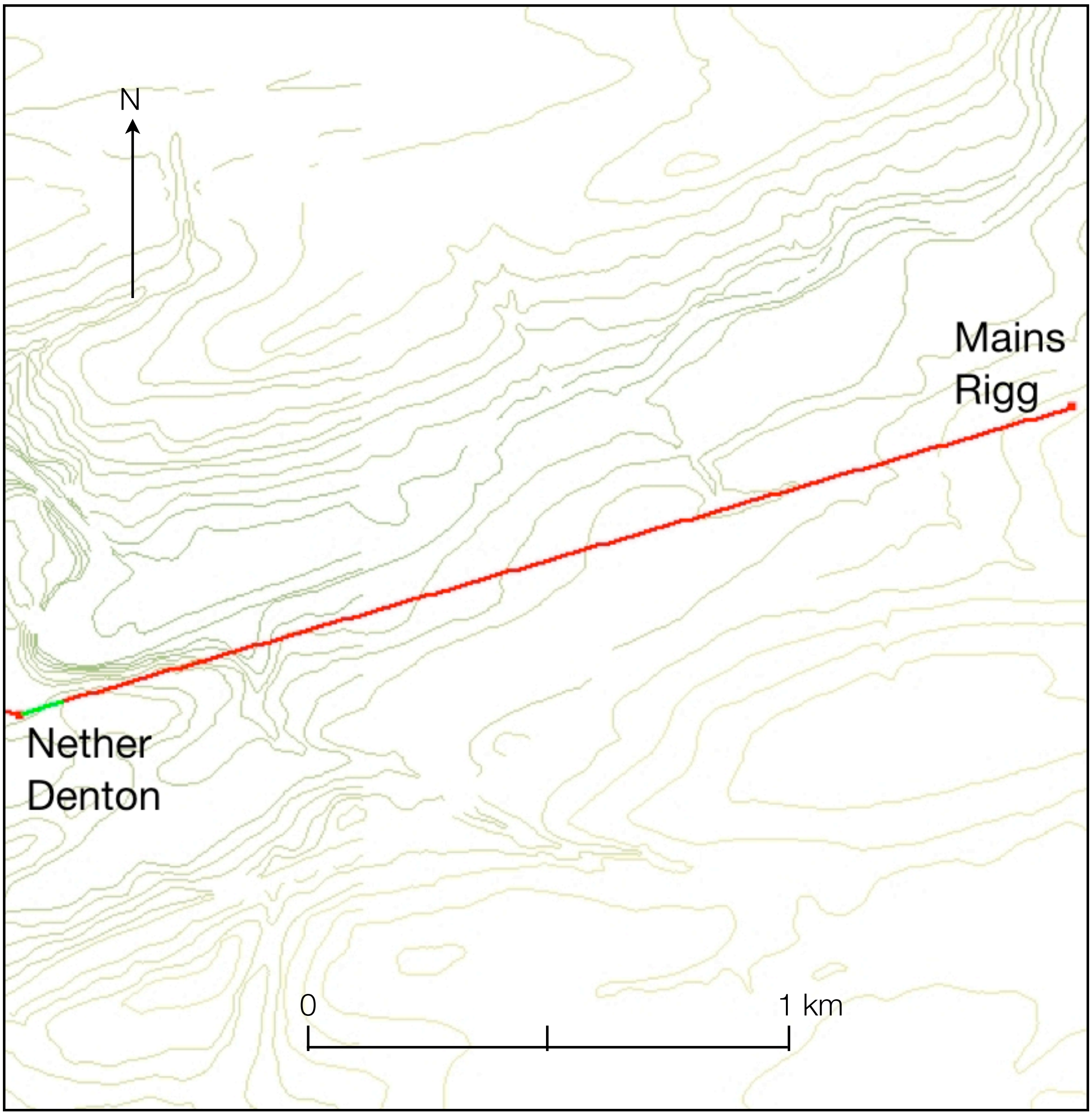


Fig. 5.10: Line of Sight 8, Mains Rigg to Nether Denton. Once again, with Nether Denton and Mains Rigg unable to see one another, these two sites are theoretically not intervisible.

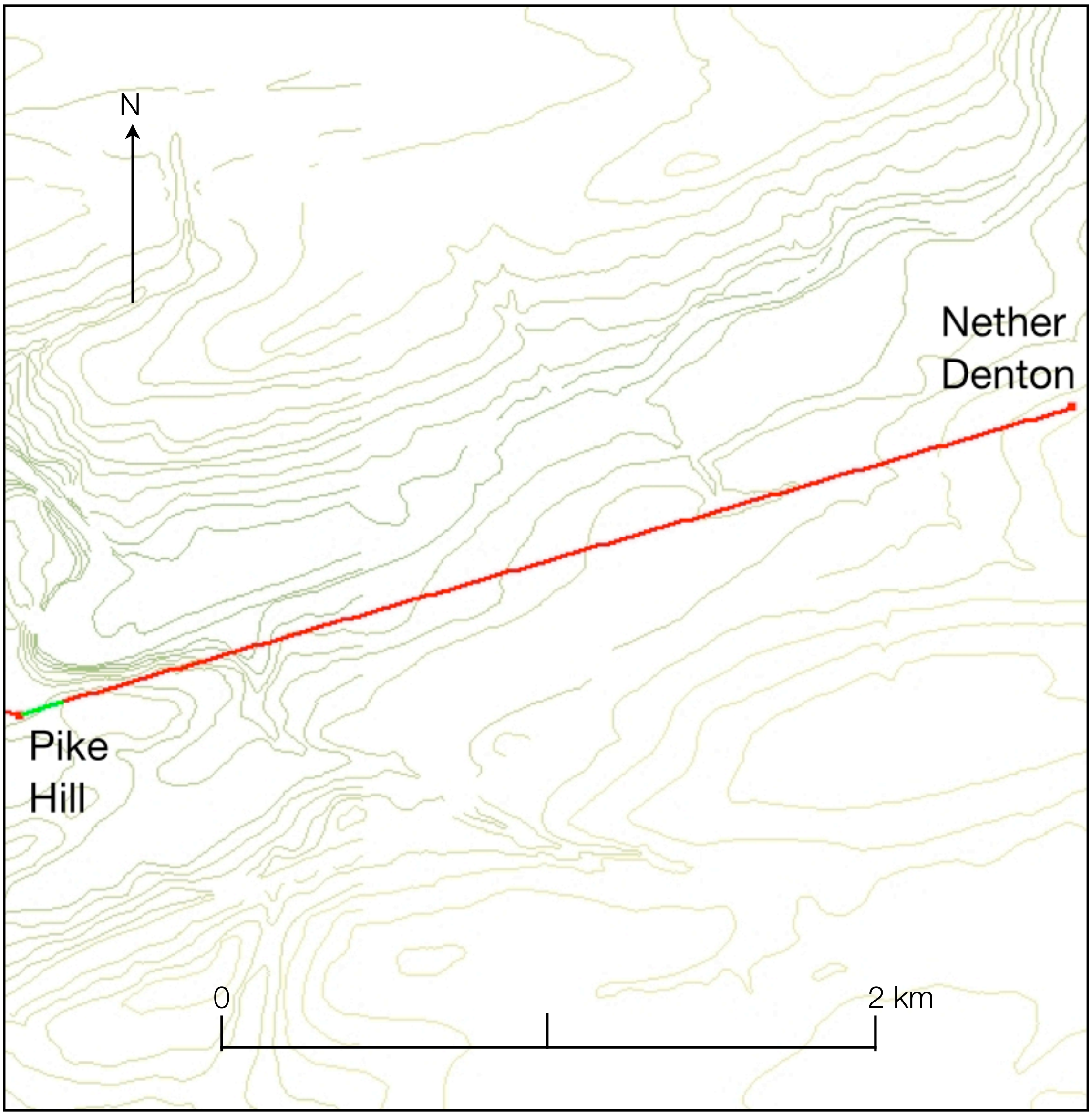


Fig. 5.11: Line of Sight 9, Nether Denton to Pike Hill. Pike Hill is shown here to be theoretically occluded from Nether Denton.

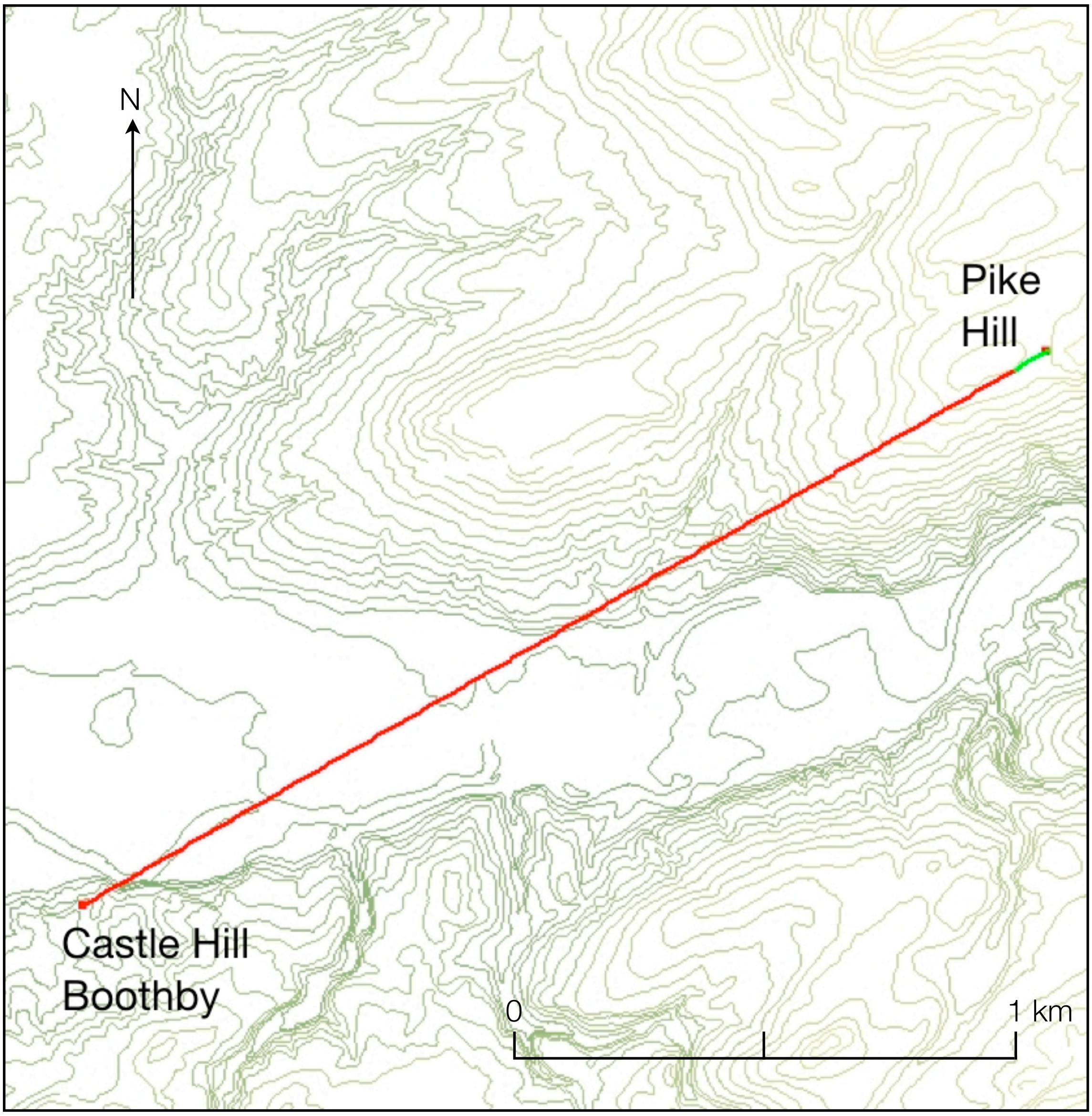


Fig. 5.12: Line of Sight 10, Pike Hill to Castle Hill Bootby. This connexion, between Pike Hill and Castle Hill Boothby, also lacks theoretical intervisibility. This is surprising as the relatively flat terrain between the two installations would have, presumably, made these sites prime candidates for intervisibility.

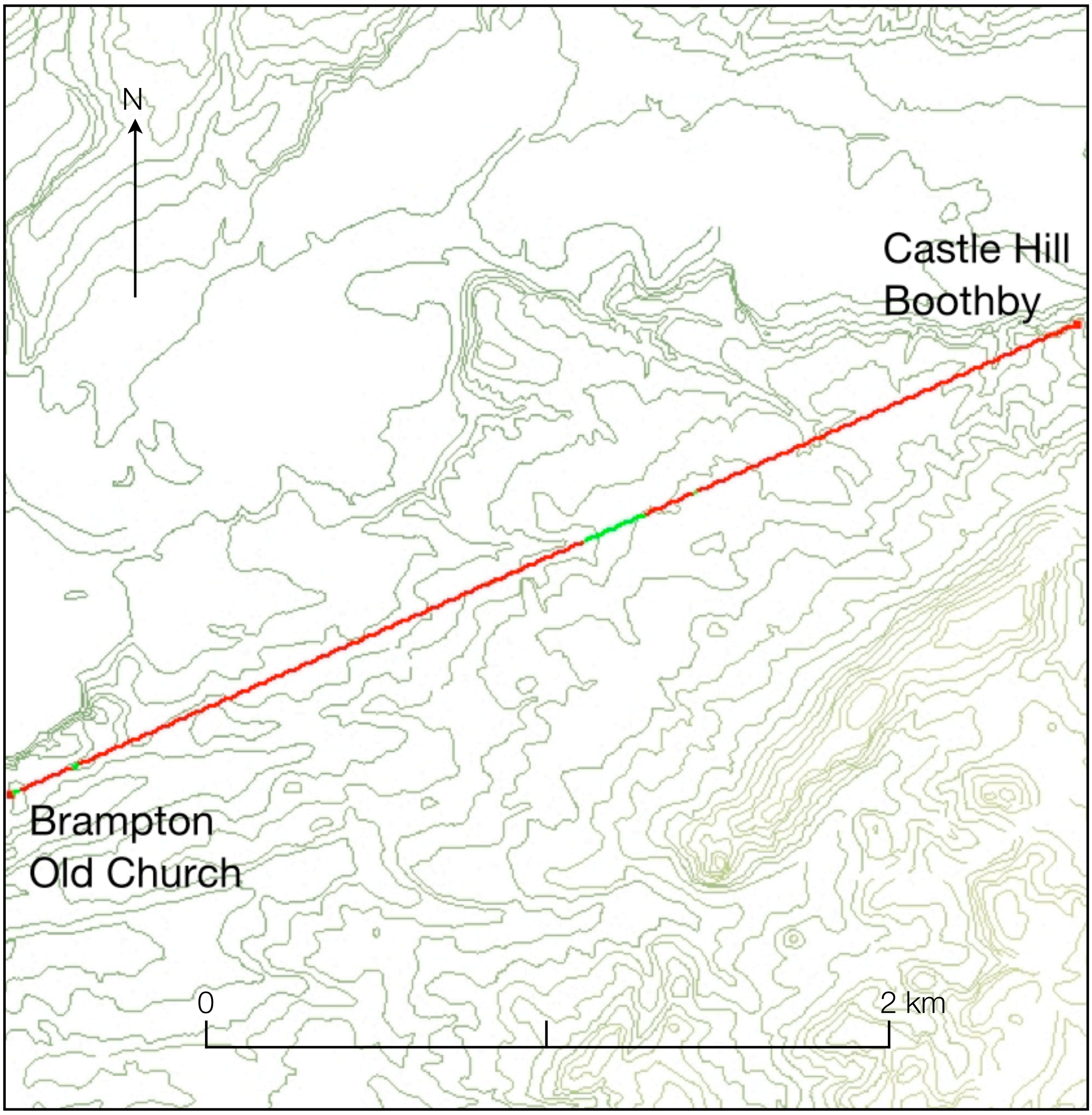


Fig 5.13: Line of Sight 11, Castle Hill Boothby to Brampton Old Church. The final site pairing reveals the same pattern as elsewhere, a theoretical lack of intervisibility, this is despite the comparatively flat terrain, which can be seen by the wide spacing of the contour lines.

§ 5.4.2.3 | Results Analysis

The digital model test shows that only the sites in the immediate environs of Vindolanda have potential as part of a signalling network. This is problematic for Woolliscroft's theory given its monocausal nature. It must be stressed that this simply demonstrates that the heights chosen here for the towers were not great enough to enable intervisibility between Stanegate sites. Nevertheless, Woolliscroft's unknown approach to tower height, combined with these results, cast doubt on the idea that the Stanegate and the Wall were organised solely around signalling.[56]

The flat land to the west of the sample site, approaching the Solway, provides the most interesting results. Here some form of interconnectivity would be expected given the comparatively low level of relief. Observing the sites of Brampton Old Church and Castle Hill Boothby in the 3D ArcScene model, Figure 5.14, reveals the reason:

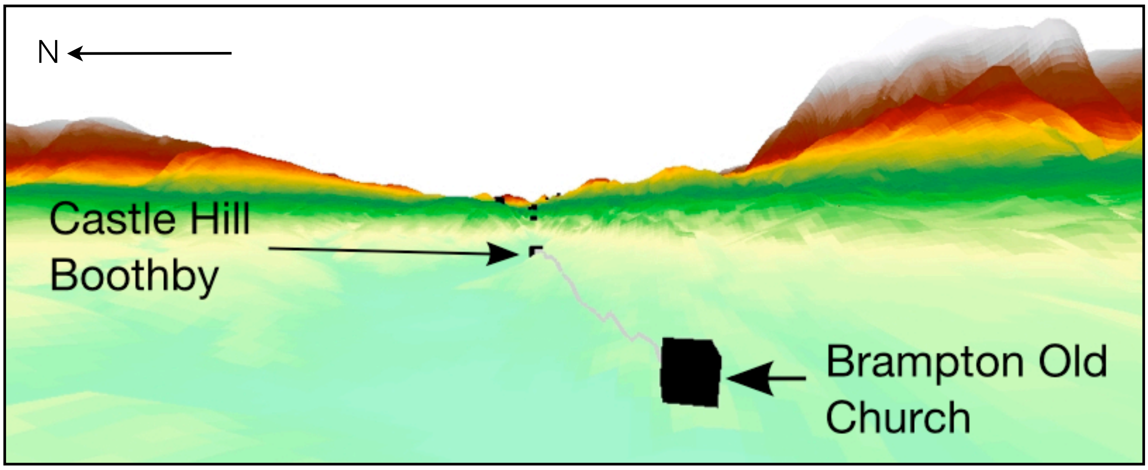
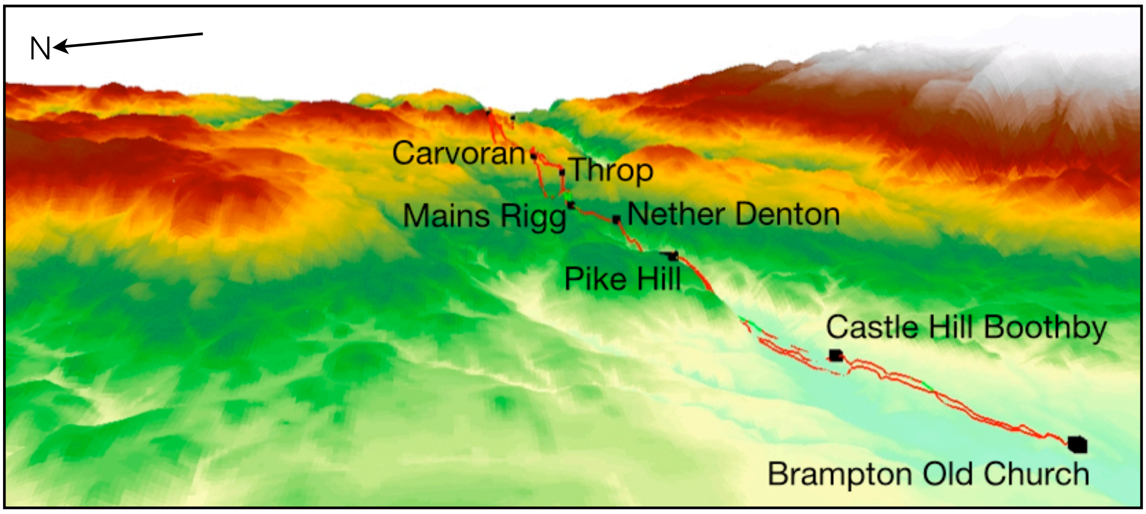


Fig. 5.14: Brampton Old Church and Castle Hill Boothby. Black cubes indicate site, not scale.

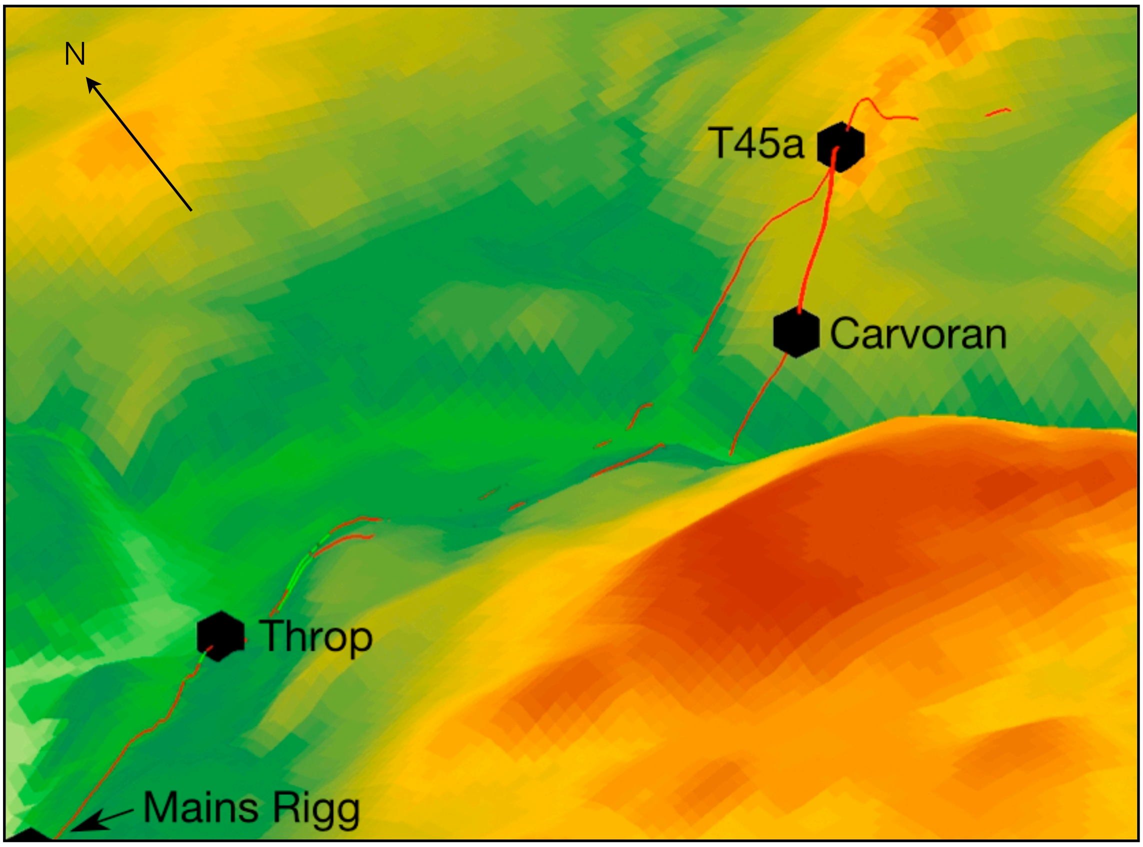
As can be seen, there is a large rise preventing the site of Castle Hill Boothby from seeing Brampton Old Church. The entire network of relationships on the western terminus of the sample group is rendered clearly on Figure 5.15:

[56] It must be noted that this is not the first failed attempt at reproducing Woolliscroft's results. Matthew Symonds, pers. comm., 2007; James Bruhn, pers. comm., 2007.



Here the main sites on the western Stanegate are rendered in 3D in ArcScene, line of sight can be seen between each of the sites and their surrounding installations. The lack of intervisibility in the central section is demonstrated on Figure 5.16:

Fig. 5.15: General topography and sites of the western Stanegate.



The complex relationship in the central Carvoran area is demonstrated here. As can be seen, rather than simply considering the area in a linear manner, that is, with Throp connecting to Carvoran which in turn connects to T45a, all different

Fig. 5.16: Carvoran and nearby sites. Black cubes not to scale.

avenues have been explored via line of sight tests. All of these return negatives for intervisibility. Indeed, with only the Vindolanda area having the possibility of being connected to a signalling network this would support Dobson's claims of the Stanegate sites being reactions to highly localised situations.[57]

The tacit implication, through use of terms like 'Stanegate system', that these reactions eventually led to the creation of frontier is not supported here. Carvoran and Vindolanda share similar environs in that they are surrounded by other installations. The fact that one could be connected to a putative signalling system, whereas the other could not, demonstrates their different responses and undermines even the unconscious evolution of a frontier, especially given that these sites are a mere 15km from each other. The emphasis is on general visibility rather than on line-of-sight intervisibility. Figure 5.17 shows a view shed of the site of Brampton Old Church:

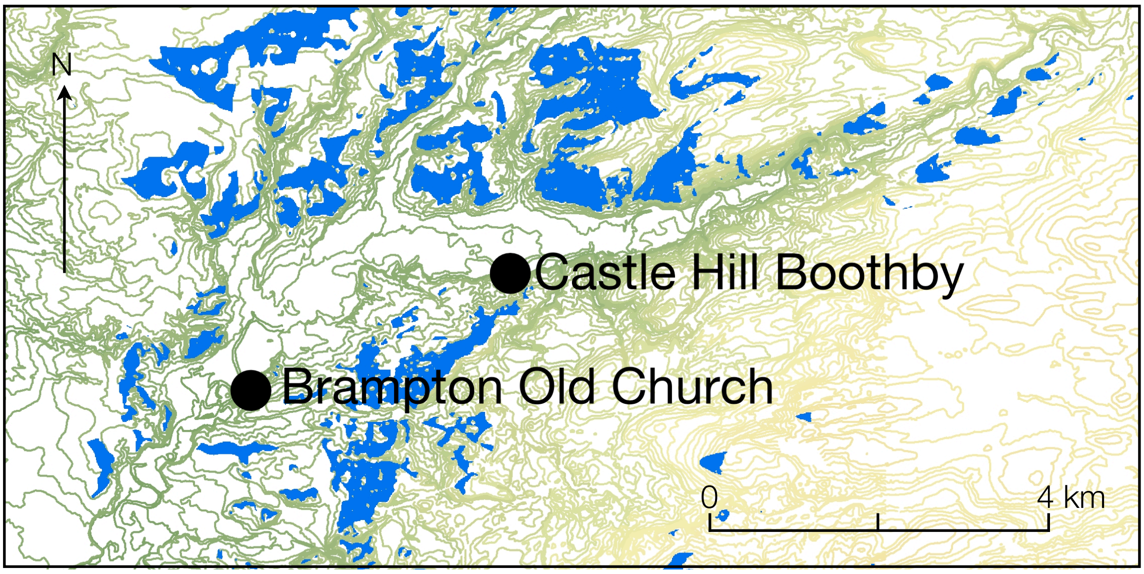


Fig. 5.17: Viewshed of Brampton Old Church (blue). Circles not to scale.

The blue on this map represents the areas that can see the site of the Brampton Old Church. As can be seen, the flat area to the north and north-east cannot see the site of the fort, and vice versa, which would be expected given the low relief of the land. Figure 5.18 is a composite viewshed taken from the site of

[57] Dobson, 1986, 5.

Brampton Old Church, shown in blue, and Castle Hill Boothby, shown in red:

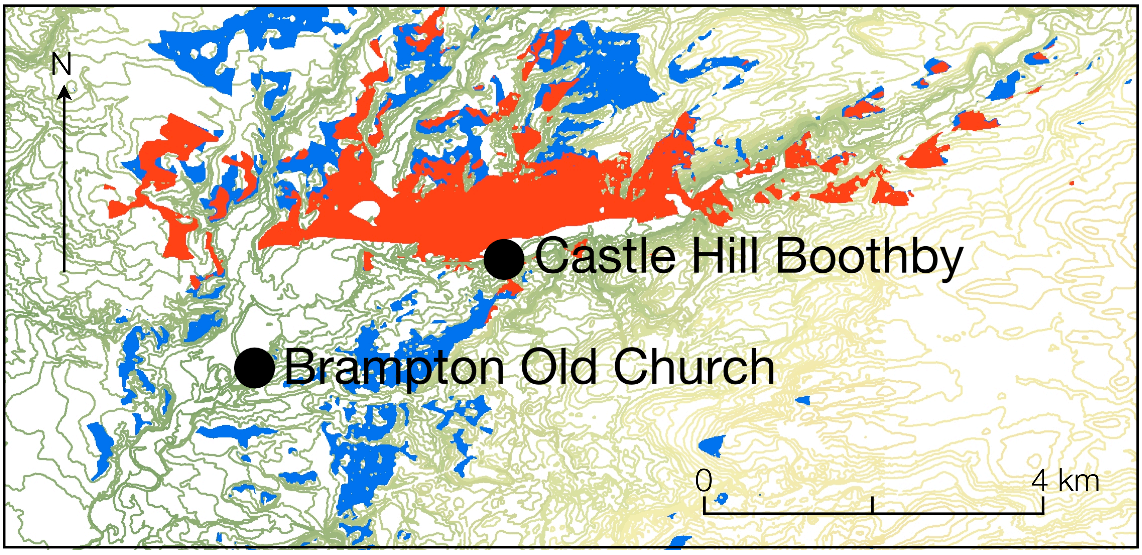


Fig. 5.18: Viewshed of Brampton Old Church (blue) and Castle Hill Boothby (red). Circles not to scale.

As is clearly demonstrated, the low relief areas which were occluded from Brampton Old Church are highly visible for the site of Castle Hill Boothby. This highlights the varied responses on the Stanegate, these results contrast with those of the Vindolanda area where site-to-site connectivity is of relevance. This agrees with Dobson's statement of varied responses without system.[58]

Clearly, with such doubt being cast on signalling as the Stanegate's, and subsequently the Wall's, raison d'être, it can be doubted whether the Stanegate can be seen as a unified system. Consequently, the Stanegate's role as an antecedent to the systematic Wall can be discounted. But can a case for similarity between the structures of the Stanegate and the Wall, thus the former influencing the latter, be seen in the quantitative survey?

§ 5.5 | The Quantitative Survey

In order to further scrutinise the tacit claims to the Stanegate's role as proto-Wall, the results of the quantitative survey[59] can be used to create a new form of comparanda between the Wall's structures and

[58] Dobson, 1986, 5.
[59] Included in full in Appendix 1.

those that occur on the Stanegate. If the Stanegate was a Wall antecedent then broad similarity in larger structures such as forts may be expected. Similarly, the Stanegate's fortlets and towers would be expected to be comparable to the Wall's milecastles and turrets.

First, considering the two towers, Mains Rigg and Pike Hill. The results are shown on Table 5.3 which compares the two Stanegate towers with the turrets of the Turf Wall.[60] The Turf Wall turrets form the comparanda because the Stone Wall turrets are structurally different in that they recess into the Curtain:[61]

Table 5.3		
Site	Work rate	Cost
Mains Rigg	561.71 person days	£163,344.60
Pike Hill	535.59 person days	£155,748.02
TW Average	523.40 person days	£146,335.89

Table 5.3: Stanegate towers compared to turf wall turrets in labour and cost.

Both of these returned a Probable Total number of person days to construct in the mid-500s.[62] This compares well with the Turf Wall figures which show an average of 523.4 person days. This does highlight the noted size of Mains Rigg, though it is not beyond compare on the Turf or Stone Walls.[63] This demonstrates that the towers and turrets of both the Stanegate and Hadrian's Wall would appear to draw on the same structural vocabulary.

The fortlets of the Stanegate seem to be the most asynchronous of structures when compared to those of Hadrian's Wall. Table 5.4 compares the work rate demands and total cost of stone-built Newbrough and Halwhistle Burn fortlets, including the Inchtuthil

[60] See §A1.4.1-2 for Mains Rigg and Pike Hill survey; §A2.20-3 for TW turrets.

[61] This itself may be another indicator that the Stanegate is not the primary influence on the design of the Wall.

[62] If an eight man garrison was assumed, as with the turrets of Hadrian's Wall, this would equate to a build time of 70.2 and 67 days for Mains Rigg and Pike Hill respectively.

[63] 54a and 19b, in west and east respectively, for example.

ratio to model internal buildings, with the stone milecastles of Hadrian's Wall:[64]

Table 5.4		
Site	Work rate	Cost
Newbrough	24,853.33 person days	£7,227,303.35
Haltwhistle Burn	34,062.15 person days	£7,717,011.55
MC Average	6,359.11 person days	£1,514,622.12

Table 5.4: Stone fortlets compared to stone wall milecastles in labour and cost.

Despite both fortlets being of quite different size, they are markedly larger than the milecastles occurring on Hadrian's Wall. Indeed, the larger of the two, Haltwhistle Burn, is almost twice the size of an average Wall milecastle. There is clearly a difference between the two types of installation. Such fortlets would have been likely to house around a century of men,[65] whereas the milecastles are thought to have housed 12-32 men, the larger figure only occurring in special circumstances.[66] This highlights the Wall's uniqueness in that structures similar in size to Newbrough and Haltwhistle Burn occur regularly,[67] whereas milecastles and milefortlets only occur on Hadrian's Wall and the Cumberland coast. In looking for the seed of the design of milecastles on the Stanegate, none is found. Furthermore, such a difference in form means a difference in function could be expected. This is further evidence against an intimate connexion between Stanegate and Wall.

What of turf and timber sub-fort sized structures? Only Throp survives in enough detail to be assessed for the quantitative survey. Table 5.5 shows the comparison between Throp fortlet, including the

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[64] See §A1.4.1-2 for Newbrough and Haltwhistle Burn; §A2.23-33 for milecastles.

[65] Breeze, 2006b, 447-8.

[66] MC47-48 have a proposed garrison of this size due to their large size and geographic position.

[67] Piercebridge, in nearby County Durham, Slack in West Yorkshire and Cappuck in the Borders are three examples of similar sized forts. Barnhill, in Dumfriesshire, at $33m^2$, Mollins and Lamington, both in Strathclyde, at *c*.$30m^2$ are smaller than the forts of the Stanegate though larger than the Wall's milecastles. This is a small but representative sample of such sites in Britain.

Inchtuthil ratio projections for internal buildings, and the turf milecastles of the western Wall and the Cumberland coast milefortlets:[68]

Table 5.5		
Site	Work rate	Cost
Throp	38,705.35 person days	£6,401,990.90
TW MC Average	4,270.68 person days	£690,786.36
CC MF Average	5,648.15 person days	£914,371.54

Table 5.5: Turf fortlets compared to turf wall milecastles and milefortlets in terms of labour and cost.

The pattern is repeated from the stone built fortlets when compared to the Hadrianic structures. Throp, as can be seen, is significantly costlier in both labour and cost than its Wall and coastal counterparts. Excluding the Inchtuthil ratio, Throp has a labour demand of 6,560.23 person days and a cost of £1,085,083.20 outstripping the TW and CC interval structures even before internal structures are modelled. Caution must be observed, however, given the small sample group sizes. Throp is but one installation, the Hadrian's Wall group is comprised of MC50 TW and MC79 TW, and the Cumberland milefortlets number four, MFs 1, 5, 20 and 22.[69] Nevertheless, the disparity in scale and the similar results from the stone-built counterparts indicates a lack of similarity between these structures. Their difference in form may well be reflected in function. The turf-built structures of the Wall and the Cumberland coast do not appear to find antecedents on the Stanegate.

Finally, the forts, all rendered in turf and timber, are perhaps harder to compare due to a lack of direct comparanda on Hadrian's Wall. Only Drumburgh survives in enough detail for the quantitative

68 See §A1.4.3-5 for Throp survey; §A2.31-3 for TW milecastles; §A3.7-9 for coastal milefortlets.

69 The appendices contain lists of structures comprising each group.

survey, shown on Table 5.6.[70] All of these forts include the Inchtuthil ratio inflation, in order to mathematically model internal structures.

Table 5.6		
Site	Work rate	Cost
Corbridge	133,125.27 person days	£22,039,890.61
Brampton Old Church	70,066.71 person days	£11,628,326.83
Drumburgh	65,376.97 person days	£9,700,701.61

Table 5.6: Stanegate forts compared to Drumburgh on Hadrian's Wall in work rate and cost.

Whilst the sample size is limited, it is interesting to note the similarity between Brampton Old Church and Drumburgh, both taking in the region of 65-70,000 person days to construct.[71] However, Corbridge requires *circa* twice the constructional effort of these forts. Whilst the turf sample size is undoubtedly small, what can be observed on Hadrian's Wall is the broad uniformity in terms of construction time and effort for its forts on the Stone Wall.[72] Despite only having one member of the Turf Wall sample group, it is telling that, with so few examples, there is already an example which is significantly different in work-rate demand.[73] This implies that, once again a Hadrian's Wall systematisation is not found on the Stanegate, and that the different sizes represent different responses to local conditions.

This analysis indicates, first and foremost, that a connexion between the Stanegate and Hadrian's Wall cannot be maintained on the basis of quantitative data. Only the towers of the Stanegate in any way conform to the turrets of the Wall,[74] the other features of Wall

[70] The most obvious omission here is that of Vindolanda. The period I fort, the most relevant for this chapter, is currently unrecoverable, lying *c*.6m below the later stone forts, Birley, 1994, 2. Sadly, even the fort contemporary with Hadrian's Wall, period V, is unavailable for comparanda as the north/south extent of the fort is unknown, Bidwell, 1985, 7, Fig.4. See §A1.4.3-5 for Corbridge and Brampton Old Church surveys; §A2.48-50 for Drumburgh.

[71] In line with the project methodology Type 1 turf structures are used as these are the least demanding in terms of cost and work rate. See §4.3.

[72] See Chp. 6.

[73] This group has a standard deviation in labour of 6,412.44.

[74] So well, in fact, that some of the signal stations saw incorporation into the Wall as T40b (Melkridge) and T45a (Walltown).

anatomy see few forebears in the Stanegate. This data combined with analysis of function[75] demonstrates that searching for antecedents to the Wall is heavily influenced by the projection of our own theories onto the Wall, and then back onto the Stanegate.

§ 5.5.1 | Total Estimated Cost and Labour

Whilst the Stanegate's surviving structures are limited, enough of each type exist to allow a conjectural estimate of its total labour and cost. This is completed for the traditional schedule of sites, rather than the extended schedule, due to its seeming lack of connexion to the other Stanegate sites. By calculating the average of the remaining structures of each type and applying this to the unknown structures, an estimate of each type can be reached. There are six forts on the line of the Stanegate, two of which, Corbridge and Brampton Old Church, have survived in enough detail to be surveyed. Thus Vindolanda, Carvoran, Nether Denton and Carlisle are all averaged and the total demand shown on Table 5.7:

Table 5.7			
Average Fort Work Rate	Average Fort Cost	Total Fort Work Rate	Total Fort Cost
101,595.99 person days	£16,834,108.72	609,575.94 person days	£101,004,652.30

Table 5.7: Total labour and cost of forts.

The Stanegate has four fortlets, three of which have survived in enough detail to be approached quantitatively, Throp, Newbrough and Haltwhistle Burn. This leaves Castle Hill Boothby as the only unquantifiable fortlet. As this is a turf built fort[76] the survey result from Throp, the only surviving turf and timber fortlet, is used as proxy. This is shown on Table 5.8:

[75] Supra, §5.3-4.

[76] Breeze, 2006b, 454.

Table 5.8				
Fortlet Type	Average Fortlet Work Rate	Average Fortlet Cost	Total Fortlet Work Rate	Total Fortlet Cost
Turf	38,705.35 person days	£6,401,990.90	77,410.70 person days	£12,803,981.80
Stone	29,457.74 person days	£7,472,157.45	58,915.48 person days	£14,944,314.91
Total			136,326.18 person days	£27,748,296.71

Table 5.8: Total labour and cost of fortlets.

The smallest and most numerous structures on the Stanegate are the towers. Out of the five total,[77] only two, Mains Rigg and Pike Hil, survive in enough detail to be calculated. The total demand in labour and cost for the towers are shown on Table 5.9:

Table 5.9			
Average Tower Work Rate	Average Tower Cost	Total Tower Work Rate	Total Tower Cost
548.65 person days	£159,546.31	2,743.25 person days	£797,731.55

Table 5.9: Total labour and cost of towers.

With each individual structure type estimated, the total labour and cost demand of the Stanegate can be estimated. This is shown on Table 5.10:

Table 5.10		
Structure Type	Total Work Rate	Total Cost
Forts	609,575.94 person days	£101,004,652.30
Fortlets	136,326.18 person days	£27,748,296.71
Towers	2,743.25 person days	£797,731.55
Total	748,645.37 person days	£129,550,680.56

Table 5.10: Total labour and cost of Stanegate.

Figure 5.19 and 5.20 show pie charts respectively breaking down the labour and cost of the Stanegate:

[77] See Table 5.2 for full list.

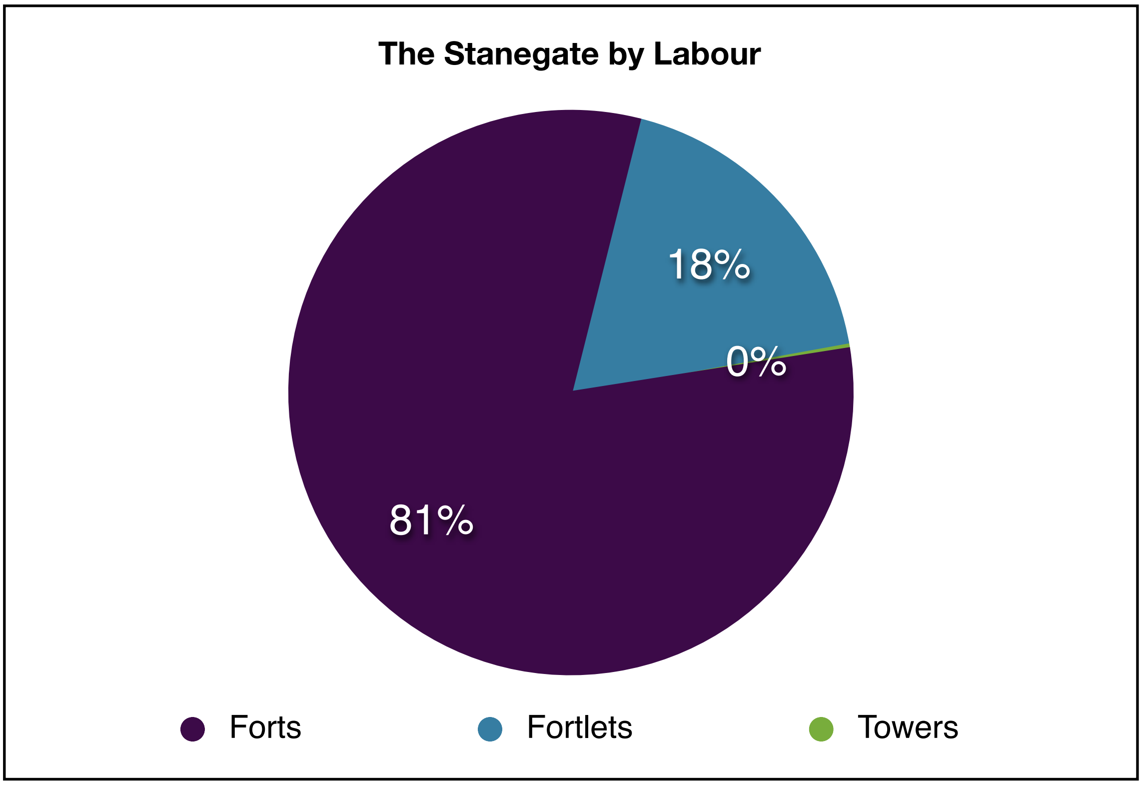

Fig.5.19: Labour by structure type.

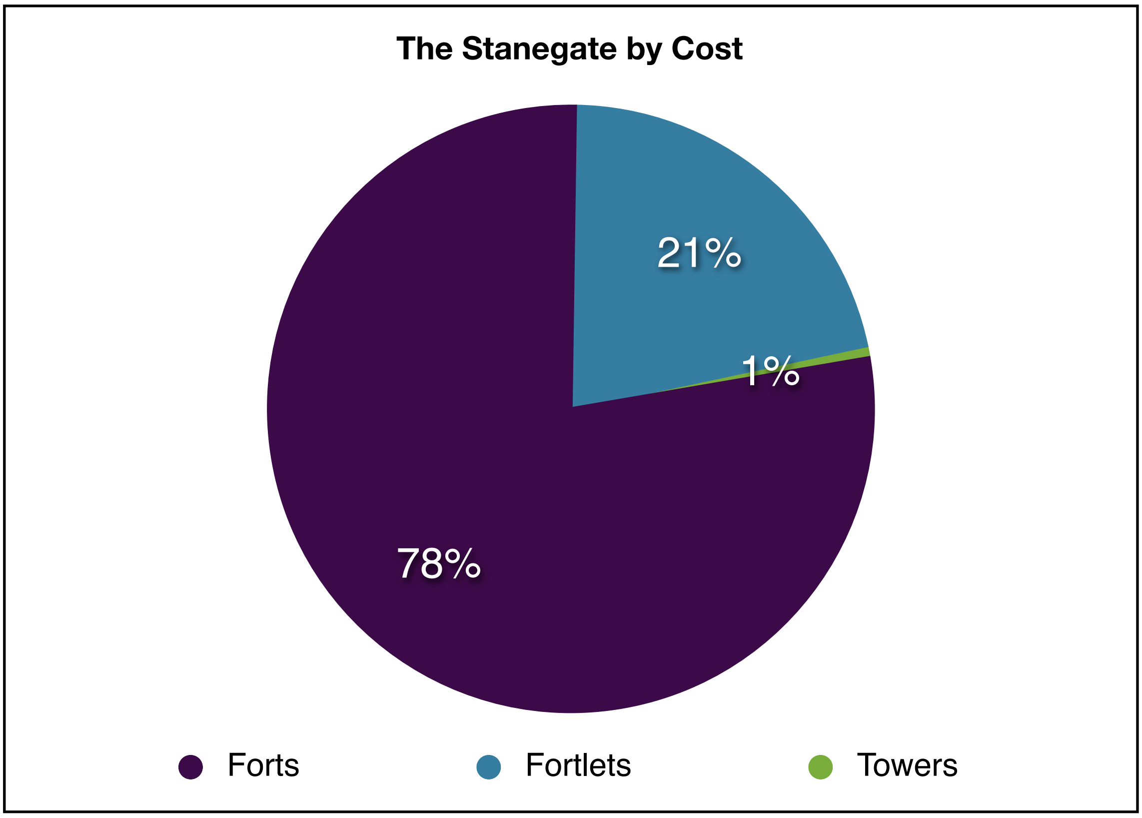

Fig.5.20: Cost by structure type.

§ 5.6 | Conclusion: Is There Any Relationship?

The above discussion has demonstrated some of the problems with analysing the Stanegate in light of Hadrian's Wall. Models which rely on the number and location of sites[78] suffer from the fact that the Stanegate most closely resembles similar lateral roads, with nothing to set it apart as a 'frontier'. Similarly, the concept of a steady development in number and type of sites creating a frontier, with turrets playing an important role,[79] struggles given the lack of systematic coverage of the Stanegate road and the isthmus in general. Even models seeking to remove emphasis for both systematic cordons and the existence of the road[80] have issues with the fact that it is the metalling which post-dates the installations,[81] thus the factors which influenced the placement of sites are unknown. Importantly, the emphasis on frontier control without systematisation or a cordon actually contradicts the idea of the Stanegate as a Wall precursor, as both these features were fundamental to the later structure. Similarly, models with intervisibility at their core[82] suffer in that their mono-causal nature is not reflected across the entire line.[83] The varying emphasis on general visibility around Brampton Old Church, or actual intervisibility around Vindolanda, emphasises this lack of system.

General issues for all Stanegate 'frontier' models can be seen in the nature of the Roman withdrawal in Scotland and the continued occupation after the construction of the Wall. This is all the more acute given the decision to move forts to the line of the Wall. Whilst some models, notably Woolliscroft's, include the Stanegate forts as originally housing the soldiery meant to operate the Wall, this would

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78 Those developed by Forster & Knowles, 1915; Collingwood & Myres, 1937.

79 Birley, 1961. Dobson, 1986, can be included as he proposes a limited system.

80 Hodgson, 2000.

81 Poulter, 1998, 54-5; Hodgson, 2000, 17, allows for the existence of an earlier unmetalled route that was realigned to take into account the newer forts. Interestingly this connects into standard Roman practice of realigning roads, with important symbolic implications. See Witcher, 1998.

82 Woolliscroft, 2001.

83 Supra §5.4.2.

have changed dramatically once the fort decision was made. That this is not reflected in the archaeology, with continued occupation on almost all Stanegate sites, weakens the claims of similar purpose between Wall and Stanegate. The quantitative approach also reveals a dislocation between the types of structures seen on the Stanegate and those on Hadrian's Wall. This combination of factors demonstrates that the traditional, military and functionally orientated interpretations do not adequately answer the question of purpose. Given these problems, why is there a search for a frontier along the line of the Stanegate?

Fundamentally, this is connected to the Wall, in much the same way that the Wall has influenced the understanding of the forms of frontiers in both Britain and Germany,[84] thus any search for a coherent system or function is merely a reflexion of discussions of the Wall's purpose. The search for a Stanegate frontier is intimately connected to explaining the existence of the Wall. With 20/20 foresight it is known by modern scholars that almost the exact same line was taken by Hadrian's Wall. The reason Stainmore Gap is not considered a frontier, despite highly similar military dispositions, is that modern scholars know that no structure similar to the Wall was developed on the same site.

Dobson's claim that '[Hadrian's Wall] had very little in the way of antecedents on the Tyne-Solway line'[85] would appear to be correct. Taking all the different theories outlined above into account, and considering their various criticisms, it seems that the Stanegate was, indeed, a road, not unlike the Stainmore Gap, built to provide lateral access between Dere Street in the east, and its western counterpart. The possibility of a pre-existing, though unmetalled road,[86] does not preclude the placement of Roman military installations which take account of localised situations, or the standard Roman practice of

[84] Supra, §5.3.
[85] Dobson, 1986, 5.
[86] Hodgson, 2000, 17.

placing forts along road routes. These aspects are not indicative of a frontier's formation.

This emphasis on the Stanegate as a normal road impacts heavily upon studies of the Wall. This conclusion is borne from the number of problems associated with the various interpretative models. Furthermore, the fact that there is a quantitative difference between Wall and Stanegate highlights their lack of connexion. This liberates the Wall from a reliance on the Stanegate as a 'response' to the purportedly hostile situation north of the Tyne-Solway line. The chronological and functional development of the Tyne-Solway isthmus has always interpreted both the Stanegate and the Wall as fulfilling the same defensive function. With the Stanegate's defensive heritage cast into doubt, the Wall is freed from its protective function, allowing a more symbolic interpretation to be applied. Most importantly, the viewsheds and line of sight tests reveal that the Stanegate is not mono-causal in its execution, this further underlines the dislocation between Stanegate and Wall as the latter's anatomy is famously rigid, resulting in a line that was militarily impractical.[87]

The consequence is that the Wall itself is not merely an extension of the Stanegate, but a unique structure in its own right. The search for the kernel of its design should expand into the broader Roman world and not just the same geographical locations. Looking for antecedents merely because the installations occur in broadly the same place hides the revolutionary nature and complexity of the Wall's structure. It is these wider norms, combined with the underlying 'formula' of Roman behaviour, that serves best in comprehending both the Wall as a symbolic entity in its own right, rather than merely a response to the same issues which faced the Stanegate. With the Wall's functional roots firmly critiqued, focus should be shifted to the symbolic.

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[87] Dobson, 1986, 6-7; Mann, 1990, 53.

VI | Hadrian's Wall

Above all it must be recognised that wild nations are pressing upon the Roman empire and are assailing every frontier, an unbroken chain of forts will best assure the protection of the frontiers.

DE REBUS BELLICIS 6.20

§ 6.1 | Introduction

Hadrian's Wall forms the core element of this study which includes the associated systems on the Cumberland Coast and the Outpost forts. This chapter presents a full quantitative survey of the entire structure and examines the ramifications of the results for understanding the structure. This addresses many functional questions that have been raised about the structure and also applies the results of the quantitative survey to understanding the Wall from a symbolic perspective. This necessitates individually examining the constituent parts of the Wall-complex: turrets, milecastles, forts, curtain and earthworks; before combining the results to reveal the full demands of the structure in terms of labour and fiscal cost. Similarly, the symbolism of each structure is considered, before an holistic interpretation of the Wall-complex is presented. In this way new light is cast on long-standing functional questions, whilst a symbolic interpretation is introduced through close examination of the structures and the application of the theories of *praxis* and *habitus*, discussed in Chapter 3.

§ 6.2 | Schedule of Sites

Hadrian's Wall cuts across the Tyne-Solway isthmus running from Segedunum in the east to Bowness on Solway in the west. The route of the curtain wall encompasses 16 wall-forts and covers some 80 wall-miles.[1] Each wall-mile is punctuated by one milecastle and two turrets, this recurs right along the length of the Wall. The Wall's course is flanked by two earthworks, the ditch to the north and the vallum to the south. The ditch is a v-shaped earthwork common across the Roman empire in military contexts. The vallum, however, is highly atypical, its central ditch took the form of an inverted trapezoid which was bracketed by two mounds interspersed by 'vallum crossings'. These were effectively causeways with an archway to permit travel through the structure.

The anatomy of the Wall-complex is more complicated than the surviving stone structures. The curtain and milecastles west of the River Irthing were originally rendered in turf and timber, being replaced some time after the seventh building season by stone structures. Similarly, the forts themselves were later additions to the line of the Wall, commenced in the third building season. The introduction of the forts created alterations in the width of the curtain wall, called the 'gauge', creating a complex anatomy with broader foundations supporting much narrower superstructures. In some areas the curtain wall shows three different gauges and further complications are added by forts like Carrawburgh, which was built around the same time as the western stone reconstruction. This complexity could imply that the Wall's function changed during construction. Nevertheless, despite these many additions and adaptations, this study's purpose, to examine the intent, design and meaning of the Wall upon completion, chronologically limits the inclusion of some of these alterations. The following sites form the schedule of chronological grounds:

[1] Metric units are used throughout this study, however, anatomically the Wall is separated along lines of Roman miles and the nomenclature of 'Wall-miles' has stuck. These are not used for calculations, all quantitative work is carried out in metric units.

Table 6.1		
Group	Included	Reason
Forts	All, except Carrawburgh and Newcastle. Western stone rebuilds included.	Carrawburgh and Newcastle were later additions (Breeze, 2006b, 216; Symonds & Mason, 2009a, 71).
Milecastles	All, including stone rebuilds in the west	--
Turrets	All	--
Curtain	Stone and turf, stone replacement in west for comparanda.	--
Earthworks	Ditch and Vallum	--

Table 6.1: Schedule of sites addressed.

As can be seen, despite the reconstruction of the turf wall taking place after the cut-off point for this study, the stone rebuilds are included. The rebuilding process casts light on the original construction of the Wall, as well as having great symbolic potential. Consequently, the rebuild is included in the analysis, though not total projections of labour demand or cost. These are excluded as the rebuild took place some time after the completion of the Wall and thus is beyond the chronological limit of this study.[2]

Not every individual structure can be fully quantitatively surveyed as many do not survive in enough detail to be considered. The turf and timber structures are particularly prone to the erosive powers of time and human activity. It is not just the nature of their materials that causes problems, but that they were actively replaced by stone successors. This results in a particularly small sample group for turf structures. Stone structures also suffer, specifically under urban sites like Carlisle. As many individual structures as possible are surveyed in order to provide the largest, most statistically sound, sample group. This sometimes requires the use of comparative

[2] See §1.1-2.

data, the average width of doorways, for example, in order to permit a structure's full survey. Whenever this occurs a note is made of the presumption, maintaining the transparency in calculation that is so important for the quantitative process. An in-depth record of the process and all assumptions accompanies the data, presented in the appendices, e.g. the assumptions made for Hadrian's Wall are recorded on Table A2.1.

The anatomy of a sample of the Wall, its forts and interval structures, is shown on Figure 6.1. This is a detail section between Benwell and Rudchester forts showing the repetitious anatomy of milecastles and turrets, the locations of the ditch and vallum and the latter's skirting of the fort sites. This is complemented by the broad geographical map of the Wall in §1.1, Figure 1.1-2.

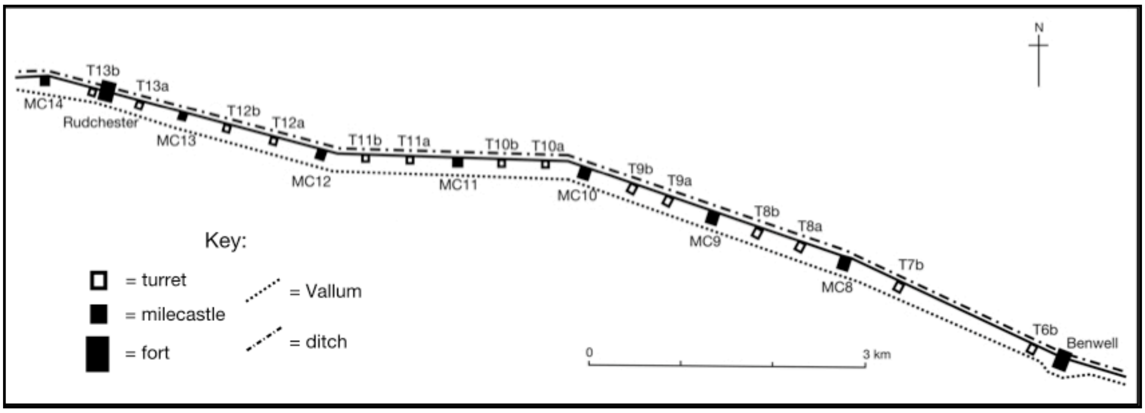

Fig. 6.1: Wall anatomy between Benwell and Rudchester.

The various elements of the Wall are now discussed, with their quantitative survey results presented alongside a symbolic interpretation.

§ 6.3 | Turrets

The turrets are the most frequent component structure of the Wall-complex. However, there are two unknowns: their overall height, and their wall-widths above the ground floor. Consequently, comparative data and conjecture are required to provide a basis for quantification. As noted in §4.5.3, wall-widths above the ground floor are informed by the evidence of MC37, where the tower had a width of 0.45m.[3] Given that this is the only evidence on the Wall for the widths of floors above ground level, this is used to interpret the first and second floors of the towers. Little is gained functionally by maintaining the wall width of the ground floor to the full height of the turret as Roman military behaviour at this time seeks to intercept opponents in the field rather than fight at the gates of a fort or wall.[4] The comparatively thin wall width of the upper floors of MC37 is further evidence that the Wall was not a defensive structure. There would have been functional benefits to maintaining the wide ground-floor gauge had defence been a purpose. Visually the structures appear identical from the outside regardless of how wide their walls are internally, though there may have been some symbolic benefit from the increased wall width through association with the higher labour demand should the turret's anatomy be known by the viewer.

The overall height of the turrets is harder to ascertain as there are no surviving examples of a full height Roman tower on the Wall. Thus, as outlined in §4.5.2 and in Figure 4.5, three heights of towers based on the Roman building 'module' of 5Rft are selected, varying between 10.2m and 13.2m.[5] Turrets are not anatomically identical, because of the different materials used for the Wall in the east and west. Whilst all turrets are constructed from stone, west of the Irthing turf is used for the curtain whereas stone is used in the east. This results in the eastern turrets recessing by varying amounts into the stone curtain wall, whereas the western wall's turrets do not have a stone curtain in which to do the same. The appearence of the turrets, however, would be largely identical, the difference in plan is shown below, on Figure 6.2:

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[3] Hill, 1997, 29.

[4] A point which can be seen in even the most functional theories. Luttwak's 'scientific' and preclusive frontier operations all involve meeting the enemy in the open. See §2.4 and Fig.2.4. Also, Mann, 1990, 54: '[The Roman commander] prevailed because he could and did outmanoeuvre his opponents. Almost always, in order to do this, he needed the open field'. Sauer, pers. comm., 2008 stresses that Classical sources do make mention of fighting near or on fortifications. However, this is almost always in exceptional circumstances, see §6.4.2 for more.

[5] See §4.5.2; Hill & Dobson, 1992, 27, 37-8; Hill, 1997, 35.

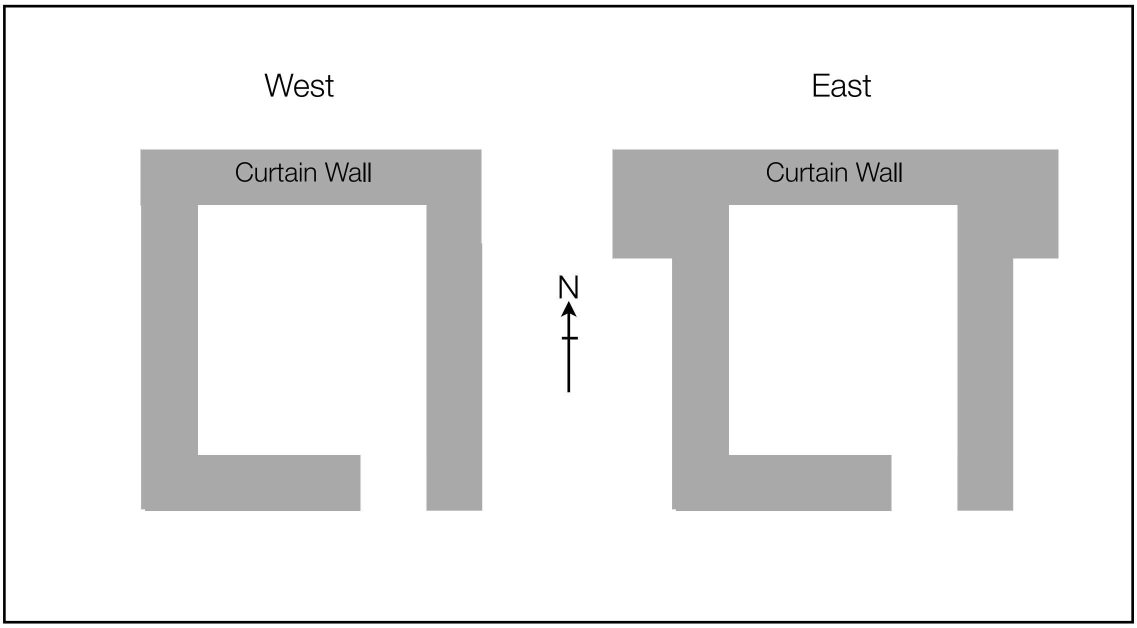

Fig. 6.2: Anatomical differences in eastern and western turrets.

§ 6.3.1 | Turrets: Quantitative Results

The anatomical differences can be seen in the average volume of the turrets east and west of the Irthing. This is summarised in Table 6.2 based on Type I turrets:[6]

Table 6.2			
Turret Group	Average Work Rate	Average Cost	Standard Deviation
East	534.52 person days	£149,441.72	107.71 (20.15%)
West	523.41 person days	£146,335.89	75.19 (14.12%)

Table. 6.2: Average labour, cost and standard deviation of turrets east and west of the Irthing.

As can be seen, there is a minor variance between the two figures, with eastern turrets requiring 2% more labour and cost to complete. Clearly these figures are negligible, they are within a margin of error and demonstrate that there was little difference between the two types of structures. There is, however, a greater degree of deviation on the eastern stone wall turrets than their turf wrapped counterparts: some 20% compared to 14%.[7] This difference is due to the differences in the curtain wall west and east of the Irthing. The eastern turrets recess into the irregular width

[6] Quantitative survey can be seen in §A2.16-19 and §A2.20-3.

[7] An average deviation of 17.14% across the whole of the Wall.

stone curtain, this was a variable which the western structures did not have to account for and leads to the greater variation seen in the east. This particular variability is therefore not indicative of differences in work gangs.

These figures provide the labour requirement and cost of Type I turrets, what of the taller Type II and III turrets? These are shown for comparison on Table 6.3:

Table 6.3				
Turret Group	Type II		Type III	
	Work Rate	Cost	Work Rate	Cost
East	585.84 person days	£163,791.54	635.03 person days	£177,542.78
West	574.84 person days	£160,715.56	626.27 person days	£175,095.23

Table. 6.3: Average labour and cost of Type II and III turrets in the east and west.

Type II turrets in the east represent a 8.76% rise in labour requirement and cost; in the west they show a 8.94% increase in labour and cost. Eastern Type III turrets show a 18.8% rise in labour and cost over Type I; those in the west require a 19.65% increase in labour and cost above the Type I turrets. Evidently, the Type III turrets require a much greater effort, and thus total cost, than their Type I counterparts. Without any discernible functional advantage, it is only in the symbolic that a benefit can be seen. This will be discussed in due course.

The different turret types and their conjectured completion times are summarised on Table 6.4. Here a build team of eight men, or one *contubernium*, is presumed. This is not only due to the fact that this was the smallest denomination of the Roman military,[8] and thus would be the most likely to be applied to the smallest structure; but also because it would appear that each turret housed approximately this number of soldiers.[9] Consequently, it is assumed that the

[8] See §9.3.2, Roth, 1999, 77-8, 82-3.
[9] Hill & Dobson, 1992, 38.

turrets were designed to be built by eight people,[10] though as always, it must be noted that the situation on the ground may well have differed with greater or fewer soldiers being used for construction depending on supply, labour availability and bottlenecks.

Table 6.4				
Turret Group	Type	Average Work Rate	Build Team	Completion Time
East	I	534.52 person days	8	66.82 days
	II	585.84 person days		73.23 days
	III	635.03 person days		79.38 days
West	I	523.41 person days		65.43 days
	II	574.84 person days		71.86 days
	III	626.27 person days		78.28 days

Table 6.4: Comparison of completion times by build team across turret types in both east and west.

The same difference is seen between the alternate turret types in terms of completion time, with Type III structures taking *c.* 20% longer to complete than their Type I counterparts. Whilst the differences are a matter of days, each type taking around an extra week to complete, this has ramifications when multiple turret construction is considered in aggregate. For example, three Type I turrets could be built in a single building season of 200 days by one building team; only two and a half Type II turrets could be built by the same build team in the same period of time. The exclusive use of Type I structures would have led to significant savings in labour, cost and materials across the whole of the Wall in comparison to the more expensive Type III turrets. Furthermore, the ability to complete in terms of whole turrets would, presumably, have been preferable to leaving incomplete structures over the winter months. This refers back to the function of the Wall, were it a purely functional structure then a strong case could be built for Type I

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[10] It must be noted that two soldiers were able to work at maximum efficiency on a turret site. See §4.8.3, Shirley, 2000, 92.

heights. However, a symbolic dimension may support the great increase in visibility and height shown by Type III turrets.

Underlying patterns in the construction of the turrets have been sought due in part to their high levels of variability compared to other interval structures. This is connected to assigning sections of the Wall to different work groups, which are called 'legionary building lengths'. For turrets, Hill & Dobson suggest a sequence of 'large-small-large-large-small' turrets' footprints to asses the different groups involved in constructing the Wall.[11] The quantitative survey provides a new method for assessing this theory through volumes. The most complete surviving series is T17a-T19b, results for Type I turrets are shown on Table 6.5:

Table 6.5				
Turret	Stone Volume	Work-Rate	Cost	Size
17a	142.71m^3	530.20 person days	£148,234.06	Small
17b	164.17m^3	609.96 person days	£170,534.47	Large
18a	140.09m^3	520.47 person days	£145,515.09	Small
18b	125.27m^3	465.42 person days	£130,122.21	Small
19a	169.40m^3	629.38 person days	£175,964.11	Large
19b	153.24m^3	569.33 person days	£159,176.26	Small

Table. 6.5: Analysis of turret size pattern.

As can be seen, this gives a sequence of 'small-large-small-small-large'. This is the opposite of Hill and Dobson's suggestion and demonstrates that seeking such patterns in a comparatively limited data set is inconclusive at best.

Grouping the turrets together in permutations of their wall-mile, that is, for example, with T17a and T17b considered a discrete unit, may provide some insight into sequencing. Once more using the sequence of wall-miles 17 through 19, a sequence of 'large-small-large' is given, by combining the totals of each wall-mile's turrets.

[11] Hill & Dobson, 1992, 30.

However, this is comparatively fragmentary sequence and is not large enough to compare to the proposed 'large-small-large-large-small' order. The more fragmentary surviving evidence for other wall-miles also causes problems for this method. For example, T12ab and T13a are so similar in size that their excavators represented them as being identical.[12] Were there to be a consistent pattern between large and small turrets T13a would have to be substantially different from those on the 12th wall-mile. Similarly, in the west T50ab and T51a are also very closely related in size, with only *c*.10m^3 of volume between the smallest turret, T51a at 127.78m^3, and the largest, T50b at 137.32m^3. It certainly appears that there is no practical difference in size between adjacent wall-miles and not enough surviving evidence to imply any form of sequencing. Clearly such differences between the turrets were not intrinsic to the design of the Wall, and whilst these may not have been connected to the 'whims of the legions', they may have been related to the differences between individual work gangs and other 'on the ground' factors, like supply.

Table 6.6	
Legion	Evidence
A	Broad Wall (1.2m), east door
B	Narrow Wall (0.9m), east door
C	Narrow Wall (0.9m), west door
Wall Mile	Legionary Group
4 - 7	?
7 - 12	B
12 - 17	A
17 - 22	C
22 - 27a	B
27a - 36b	
36b - 43	A
43 - 49	C
49 - 54	B
54 - 59a	C
59a - 64b	A
64b - 70	B
70 - 75a	C
75a - 80b	A

Table 6.6: Legionary building lengths and evidence for identification.

Given that patterns of both volumetric calculations and footprints seem not to provide insight, the other criteria for assessing build teams must be considered. This is through the width of the north

[12] Simpson, 1931, 322.

wall and the placement of the doors. The wall-miles, legionary group and criteria are shown on Table 6.6. Of the legionary building lengths group C, with the western doorways providing a unique trademark, are the easiest to identify. Group C includes the 'narrow wall' of c.0.9m width, yet T17ab have north wall widths of 1.52m not meeting the criteria. Similarly, T18a and T19ab are assigned to group C yet they have wide north walls.[13] In other group C areas a similar pattern emerges, T44b and T45b have north wall widths of 1.83m and 1.4m respectively.[14] Clearly these are much too large for the classification proposed. Only wall mile 48 out of 24 provides turrets which match the criteria for legion C, with north wall widths of 0.96m and 0.84m respectively.[15]

What of the other groups? Legion B is the most inconclusive in the east. The whole surviving group; T7b, T10a, T25b and T26ab; possessed north wall widths greater than the 0.9m supposed.[16] The western Wall provides group B with some conformity to its legionary building group as all but T50a and T54a conform. This, however, is likely to have been connected to the design differences of the east and west brought on by the stone curtain, shown on Fig.6.2, rather than with differences in legionary unit building styles. Group A is perhaps the closest fitting group to its criteria with all but one turret, T39a, not conforming.[17] In light of these issues it is impossible to assign the variability in turrets' structure to the unit involved in their construction.[18] Indeed, this exercise illustrates the problem with using terms such as 'broad' and 'narrow', as these classifications seem not to apply to the structures on the ground.

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[13] T18a: Birley *et al.*, 1932, 258, Pl. XLVII; T19ab: Birley *et al.*, 1933, 98-9, Pl. VI.

[14] T44b: Gibson, 1903a, 17; Newbold, 1913, 70, Pl. II; T45b: Bruce, 1883, 235; Newbold, 1913, 70, Pl. II.

[15] T48a: Shaw, 1926, 438, Fig.2; T48b: Shaw, 1926, 431, Fig.2; Shaw, 1927, 236.

[16] T7b: Birley, 1930, 146; T10a: Bennett, 1983, 32-40; T25b: Woodfield, 1965, 108-21; T26a: Woodfield, 1965, 128-42; T26b: Newbold, 1913, Pl.2.

[17] T39a has a north wall width of 0.84m, all other group A turrets range from 1.11m (T79b) to 1.98m (T12ab, T13a). See Breeze, 2006b, 481-2, 486-8, 492-3, 494-5 for excavation reports.

[18] This is in line with Hill & Dobson's analysis, 1992, 29: 'the variations between turret and tower are not due to the whims of the individual legions.'

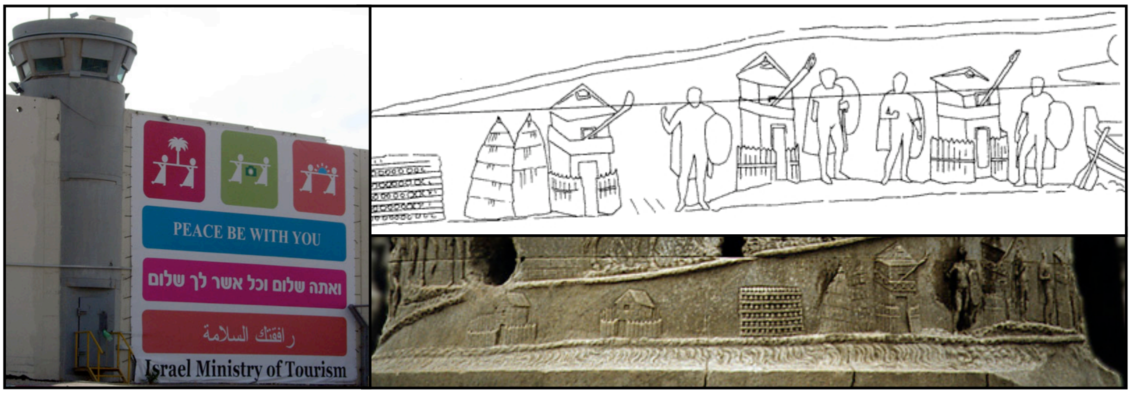

Fig. 6.3: Left, modern Israel 'Peace Wall'. Bottom right, scene 1 of Trajan's Column; top right, cartoon of scene for clarity.

§ 6.3.2 | The Symbolism of Turrets

Turrets are traditionally thought to have served as watchtowers or as part of a wider signalling network.[19] There is a combination of factors which contribute to this interpretation: the anatomy of the towers and the role of broadly comparable structures in the modern world, combined with Roman representations such as 'watching the Danube' on Trajan's Column, shown on Figure 6.3.

However, this concentration on functionalism hides much of what could be said about the symbolic power of such structures. Firstly, whilst the great height of the Wall's towers, perhaps a maximum of 13.2m, does indeed facilitate a watching over the land, it also allows for the tower and those manning the structure to be seen from far afield. Thus there is a symbolic aspect to the functional purpose of the structure with one supporting the other. This can be seen on the Israeli Peace Wall, Figure 6.3, where the wall's function also includes a propaganda dimension. Furthermore, the construction taking place at height allows the act of building to be seen more clearly across the landscape.[20] This symbolic purpose provides the best reason for considering the larger builds of Type II and III turrets. Whilst the project methodology uses the lowest figures in case of

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[19] Dobson, 1986, 5, 7: 'The effectiveness of the Roman barrier […] depended essentially on the level of watchfulness maintained'; Woolliscroft, 2001, 63-78.

[20] Importantly, the turrets as the structures with the greatest height have the largest amount of stone work that needs lifting up the height of the scaffold. This further emphasises Roman technical ability.

doubt,[21] an exploration of the gains made by building to the higher Types II and III structures is worthwhile.

Given that the key characteristics of the turrets are their height and visibility, what would be the significance of this for the Romans? A building of uncharacteristic scale, especially in a landscape largely devoid of similar structures, would overwhelm the viewer in both physical and symbolic terms. This is extremely important in the Roman context due to the importance of the *genius loci*, gods of place.[22] Consequently, the construction of such tall buildings can be connected to Roman attempts at appropriating both physical and psychological space. As can be seen from this, the process of appropriating the landscape was not a 'gentle' act, and such large-scale structures challenged the status-quo of the pre-existing *genius loci* of sites along the line of the Wall allowing their replacement or realignment along Roman lines.[23] Indeed, syncretism of deities, and the representations of power imbalance and resistance this process involved, may well have gone hand-in-hand with major construction works as 'native' elites sought to outdo one another through patronage of structures.[24] This took place under a Roman framework which provided opportunities for advancement under the terms of the *pax Romana*.

Furthermore, part of this process can be directly connected to the emperor himself. That emperors sought to characterise their principate through structures is important,[25] rendering an explicit connexion between their structures and the emperor himself.[26] As will be seen, the Wall was such a great commitment in terms of labour, time and cost, that the authorisation, and potentially the

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[21] See §4.3.

[22] Evans, 1988, 93; Fredrick, 2003, 205-6.

[23] Webster, 2006, pers. comm.

[24] Zanker, 1988, 297-333; Webster, 1997, 175.

[25] Gunderson, 2003, 645; Thomas, 2007, 30.

[26] Lazzari, 2005, 127: 'Material objects render palpable infinite kinds of relations, sensations, thought and actions […]'.

Fig. 6.4: Ilam Pan, with inscription possibly naming the Wall as vallum Aelii*.*

design,[27] of this structure could only have been granted by Hadrian himself.[28] The Ilam Pan, found in Staffordshire in 2003 and shown on Figure 6.4, indicates a more direct connexion between Wall and emperor. Its inscription, citing *vallum Aelii*, can be interpreted as indicating that the original Roman name for Hadrian's Wall was the Wall of Aelius, thus involving Hadrian's family name.[29] Trajan capitalised on a similar connexion between his person and his principate in the structure of his Danubian bridge. This was fitting for a military emperor as it connected him into a tradition of military bridge-building tradition which included Caesar, Gaius, Domitian and even Xerxes and Darius of Persia.[30] Importantly, the esteem in which the bridge is held is connected to that of his person. Structures were not unpopular because they are flawed, but rather because their patron is perceived in a poor light, the obverse was also true.[31]

Importantly, the bridge served both a military need and sustained the memory of the Dacian wars. In this sense Trajan's Danubian bridge was very much a victory monument, it connected to the 'truth' of Trajan's reign as a militarily successful emperor on both a practical and symbolic level. In a similar vein, anyone using the bridge would be aware of the connotations and connexions back to Trajan and his victories over the Dacians. In this sense the *praxis* benefits of the bridge can be seen as it reinforced Trajanic imperial ideology.[32]

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[27] Thomas, 2007, 26.

[28] Mann, 1990, 52.

[29] Breeze, 2006b, 35.

[30] Thomas, 2007, 5. Caesar considered crossing the Danube by boat, rather than building a bridge, not 'in keeping with his own dignity or that of Rome'. […] sed navibus transire neque satis tutum esse arbitrabatur neque suae neque populi Romani dignitatis esse statuebat, Caes. *BGall.* 4.17; Mattern, 1999, 119.

[31] Fredrick, 2003, 203.

[32] See §3.3.1.

Applying these ideas to Hadrian's Wall, and specifically the turrets, means that when viewing the Wall, the emperor and his reign is reified. Importantly, whilst the Wall is not a structure connected with a particular military victory, it is fused to the projection of imperial power. In the first instance the height of the turrets and the scale of the curtain overwhelmed the eye, the Romans perceive vision as the most powerful sense as it extends the furthest from the body thus this emphasised Roman might.[33] This is the first point in a series of both subtle and flagrant stresses of power embodied in the Wall's structure, including its height and scale. The larger building types, II and III, thus have a psychological reason for their use. That the curtain would actually extend out of sight would serve to underline this control and domination of personal space and senses.[34]

With the turrets and the Wall effectively providing a space for imperial power to reside, including Hadrian's presence, any space from which the structures are visible contributes to emphasising this power imbalance. The area from which the Wall was visible stretched across a wide area due to the height of the turrets, thus the greater the stature of these structures, the more potent the effect. Similarly their repetitious appearence would have made avoiding the symbolic presence of the structures impossible. This powerful symbolism is further compounded by the physical presence of the soldiery. The Wall has been described as 'merely a piece of Roman rhetoric',[35] however, this grossly underplays the importance of rhetoric in the Roman world.[36] The soldiers contributed as their presence, to continue the metaphor, prevents the Wall from being empty rhetoric. In short, it is their presence and their actions which help concretise the Wall's symbolic power.

This soldierly presence provided a tangible link to the victories of Rome. Their presence, and importantly the structures they build,

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[33] Fredrick, 2003, 217-20; Thomas, 2007, 208.
[34] Thomas, 2007, 208.
[35] Mann, 1990, 54.
[36] Mattern, 1999, *passim*.

make an explicit connexion back to the institutions, majesty and power of Rome. The act of building a structure as high as a turret would have made the process visually prominent and displayed Roman technical excellence and superiority in the field. The sheer fact that they are able to build structures tacitly embodies victory through the availability of land for Roman use. The use of stone rather than turf and timber in the construction of the turrets was crucial. Not only does this connect to issues of liminality, as will be discussed with regard to the curtain, but the fact that stone is harder to obtain and work, and lasts longer, further underscores the technical achievement of the structure.

Abstractions can also be connected to the soldiery. The association of soldiers with the governing of the province and the civilian courts of law,[37] as well as being subject to their own legal code, meant that those dealing with 'Rome' in many aspects of life would be aware of the power of the army. The separate legal code of the soldiers emphasised this power as well as their simultaneous separation from its consequences. Power imbalance was a tool of promoting Roman *maiestas*. Whist an esoteric connexion, the fact that the governor was in turn linked to the emperor was important as it again reifies the emperor amongst the very fabric of the Wall through the institutions of his power, over which he, or his sanctioned governor, presided. Naturally, these institutions include the legions and the auxiliary units and are symbolically powerful, a fact underlined by the discussion of Roman military defeat rendered in terms of damage to the legionary institution, and its *maiestas*, rather than in terms of loss of life.[38]

Thus the turrets, as the Wall's most numerous interval structure, form a key component in projecting *maiestas*. Their height and regularity made them all but impossible to avoid for anyone looking to traverse the line of the Wall. Similarly, their structure is designed

[37] Mattingly, 2006, 129, 164.
[38] Mattern, 1999, 189.

to achieve the competing goals of pacifying and creating new space, alongside emphasising discrepant power relations between the viewer and the object. Throughout, imperial immanence is reified and made real by the structure and its manning. Finally, the very presence of a structure and the act of its construction demonstrated these concepts in the most physical way.

§ 6.4 | Milecastles

As with turrets, the milecastles require certain assumptions to be made and applied to them as a group in order to complete the quantitative process. Due to the direct evidence from MC37 for wall widths above the ground floor, a tapered width of 0.45m is assumed for all tower walls. The heights of the towers are informed by the assumptions made for the turrets, the height of 4.37m is applied to the ground floor due to the evidence from MC37, the second and third floors of the towers are broken down into three types which are the same as the top two floors of the turrets.[39]

Perhaps a more fundamental question than the total height of the structure is the materials from which they are made. The idea of a stone ground floor, with wooden structures forming the first and second level is not new,[40] and Trajan's Column provides some corroboration with timber gateways and towers occurring in each of the first 25 scenes,[41] shown on Figure 6.5. However, there is direct evidence from Hadrian's Wall for stone structures above the ground floor. The discoveries of stone window heads at MC39 and T44b argue against a wooden upper section on the interval structures of Hadrian's Wall.[42] Consequently, this study assumes that the upper floors of the Wall's structures are made of stone.

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[39] See §4.5.2 and Fig.4.5.

[40] Gibson *et al.*, 1911, 15.

[41] Hobley, 1982, 231-3 gives an in-depth run down of the representations of structures on Trajan's Column.

[42] Frere *et al.*, 1983, 290; Hill & Dobson, 1992, 29, 36, 37. The existence of the windows also makes the second floor highly likely. There would be no purpose in having single floor towers over the gates as the same increase in height could be achieved by standing on the Wall.

Fig. 6.5: Left: legionaries working both stone and wood. Right: fortress constructed with both materials.

This example highlights the problems of too literal an interpretation of Trajan's Column. It may well be the case that the column's freeze was designed to demonstrate the technical mastery of Roman citizen-soldiery over all forms of construction, be they stone based or turf and timber. Similarly, the representation of stone, timber and composite structures, combined with the exploitation of the materials, promotes powerful propaganda about Rome and combines the meanings of these structures and actions in one monument. Also, it must be noted that Trajan's Column is not exactly contemporary with the Wall. By the time of Hadrian, forts rendered entirely in stone were the norm,[43] thus the Column represents Trajan's age and not that of Hadrian's. Furthermore, this represents the Roman army in the field, on campaign, and not during peace-time, as would have been the case with the construction of Hadrian's Wall.

The floor-plan of the milecastles' towers is another area where the lack of surviving structures at first floor level causes problems. The piers which supported milecastle towers are thought to have been functionally connected to the operation of the gateways rather than the presence of towers. However, there is evidence from Type II, III and IV gateways, shown on Figure 6.6, that their form may be connected to the towers, rather than solely to the operation of the gateway.

[43] Hanson, 1996, 354.

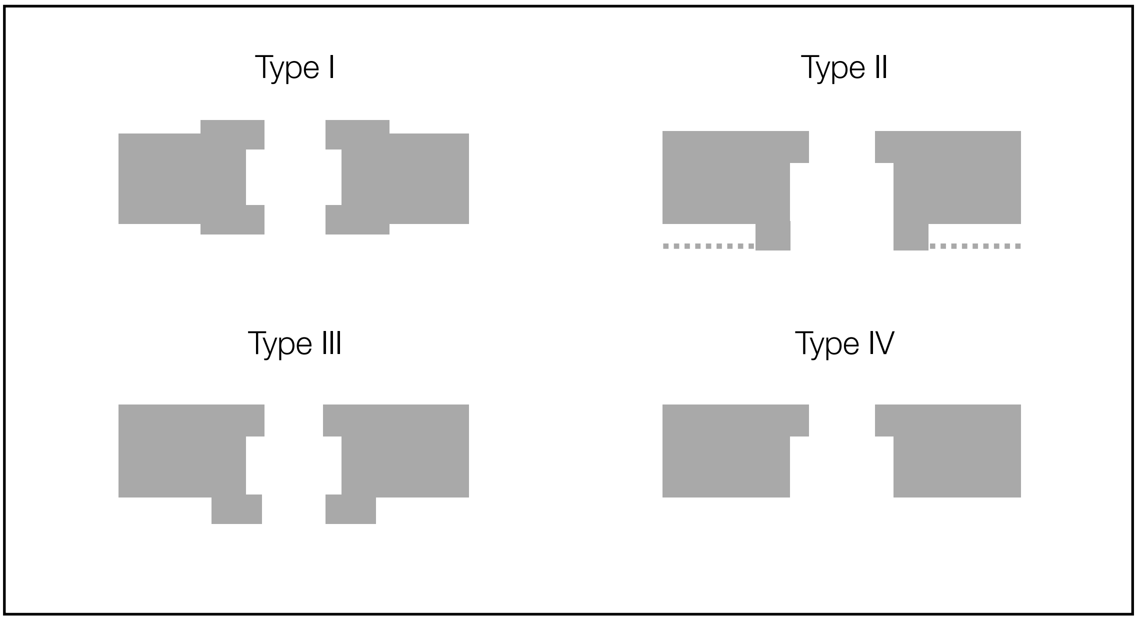

Fig. 6.6: Milecastle gateways. I, III and IV were 'broad wall'. II, a variant of IV, was found on the 'narrow wall'.

Of the four types, the third has perhaps the most clear connexion to the milecastle's towers. The rear projection of the piers provided extra available surface area for the tower's floor,[44] the same can be said of Type IV and its Type II variant. Indeed, Types II and IV are the most interesting for the towers, as the gateways of Type II could operate without the rearward projection of masonry. Thus the only structural explanation for the rearward masonry is to provide a larger surface for the tower's floor. This highlights the link between the gateways and the floor-plan of the towers above them. Consequently, for the quantitative calculations, the area around the piers is taken as forming the area of the floor-plan of the towers. This area is external, the internal area has the 0.45m wall width removed.

Importantly, both the north and south gates of milecastles are identical,[45] thus they both had the capacity to carry towers. The need for towers on the south gateway can be seen in connexion with the role of vallum. A functional purpose as a military marker is often presumed for this earthwork,[46] demonstrating that projection of a Roman presence to the south was just as important as to the

44 A Type III gateway would provide an extra $2m^2$ area on each floor. Hill & Dobson, 1992, 36.

45 Hill & Dobson, 1992, 36; Breeze & Dobson, 2000, 33.

46 Dobson, 1986, 18.

north.[47] This factor, when combined with the importance of boundaries in the Roman idiom of construction,[48] implies that even without the structural evidence of the south gateways a convincing case can be built for towers on the south wall. Consequently, two towers are assumed for milecastles, one over each gateway.

§ 6.4.1 | Milecastles: Quantitative Survey

Of the 80 wall-miles, some 19 milecastles survive on the stone wall, two on the turf wall and six stone replacements west of the Irthing. Their average demands in terms of labour and cost are shown on Table 6.7, alongside their standard deviation:[49]

Table 6.7			
Type	Work Rate	Cost	Standard Deviation
SW Milecastles	6,359.11 person days	£1,514,622.12	1,588.15 (24.97%)
TW Milecastles (Turf)	4,270.68 person days	£690,786.36	158 (3.70%)
TW Milecastles (Stone)	7,096.07 person days	£1,703,983.66	1,177.53 (16.59%)

Table 6.7: Milecastle labour demand, cost and standard deviation.

As can be seen, in terms of labour and cost the stone-built milecastles are, unsurprisingly, closest to one another. This is doubtless due to their use of the same materials, and serves to highlight how comparatively expensive it is to work in stone rather than turf and timber. This similarity is also reflected in the stone milecastle's comparable standard deviations. The low deviation on the turf-built milecastles may be similar to that seen on the Cumberland coast,[50] a connexion between such scant deviation and lower numbers of work gangs may be suggested. However, the sample group comprises a mere two specimens, and any

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[47] That the vallum took a different form from the northern ditch was connected to the use of the Wall-complex as a structure to be traversed. This is considered in §6.7.2.

[48] Rykwert, 1976, 62.

[49] Type I turf and timber structures presumed; Type I towers presumed. For survey see §A2.24-30 for stone structure, §A2.31-3 for turf, §A2.34-9 for stone rebuilds.

[50] See §7.4.

conclusions drawn from this very limited number of examples must allow for this.

The assumption of a design connected to garrison size generates interesting results for the structures' completion times. The garrison size itself is dictated by the need to operate the two gates of the milecastle. A total of 12 men, with four working and eight resting at any given time, is considered acceptable.[51] Yet, as can be seen from Table 6.8 none of the structural groups can be completed very swiftly by assuming a relationship between garrison size and structure.[52]

Table 6.8			
Type	Work Rate	Completion Time	Garrison
SW Milecastles	6,359.11 person days	477.09 days	12
TW Milecastles (Turf)	4,270.68 person days	355.89 days	12
TW Milecastles (Stone)	7,096.07 person days	502.94 days	12

Table 6.8: Completion times of milecastles with a build team of 12 persons.

The stone Wall milecastle can be seen to take more than two building seasons. However, with the basic denomination of the Roman army being the *contubernium*, the use of one and half of such units could prove unnecessarily complex, especially given that unit supply seems to have been predicated on this unit.[53] Consequently it is worth exploring whether permutations of eight men were possible. Firstly, the primary issue of where the soldiers are to sleep is a problem. A garrison of 12 soldiers cannot be accommodated by the milecastle's barrack block alone as this housed only eight people. There are two solutions to this issue, the first is the 'hot bed' system, the second is the use of the milecastle towers. There is evidence that the Wall's turrets housed soldiers for

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[51] Hill & Dobson, 1992, 37; Breeze & Dobson, 2000, 41.
[52] MCs 47, 48 and 52 are assumed to possess garrisons of 32 soldiers.
[53] See §9.3.2.

extended periods of time.[54] Furthermore, they provided space for 'at least twelve men'[55] over the top two floors. Given the parallels between turrets and towers it is assumed here that the space provided in the milecastle towers could be used for accommodation to provide additional space to that of the barrack block. This removes the need for 'hot beds' that even the lowest estimation of milecastle population required, and allows an increased estimate of how many men could be housed comfortably in a milecastle.

A garrison of two *contubernia*, 16 men, would provide a number of advantages. Firstly, it allows for easier rotation from the parent fort, an important factor when supply is considered, and would reduce the intensity of the work regime at the milecastles. Table 6.9 shows how this would affect the completion time of each of the milecastle groups:[56]

Table 6.9				
Type	Work Rate	Completion Time	Garrison	Difference
SW Milecastles	6,359.11 person days	365.74 days	16	-111.35 days
TW Milecastles (Turf)	4,270.68 person days	180.99 days	16	-88.98 days
TW Milecastles (Stone)	7,096.07 person days	390.46 days	16	-200.88 days

Table 6.9: Completion times of milecastles with a build team of 16 persons.

Interestingly, breaking the milecastles down into separate groups highlights internal differences. Clearly the extra labour results in great savings in time for construction, with the stone rebuild in the west taking an entire building season less to complete. The size of the stone rebuilds, however, render them distinct. This is clearly connected to the fact that the construction of the stone replacements was taking place over a limited area of the Wall. As a consequence more labour is likely to have been available, which

[54] Allason-Jones, 1988, 197-218: Evidence for occupation occurs at T7b, T10a, T17a, T18ab, T25b, T26a, T29ab, T30b, T31ab, T33b, T35a, T38b, T39a, T44b, T45a, T48ab and T49b..

[55] Hill & Dobson, 1992, 49. They are listed as having an average size of 18.32m^2 per floor. Milecastle towers, estimated from the area above the gateways, compare favourably with an average size of 19.37m^2 per floor.

[56] As with Table 6.8, 32 person garrisons are assumed for MCs 47, 48 and 52.

made the construction of these comparatively labour-intensive milecastles possible.

Rather than simply looking at the milecastles as a group, there are interesting atypical examples, the most noted of which are MCs 47, 48 and 52. As many as 64 men have been postulated as having resided in these milecastles,[57] however a more conservative estimate half that figure would appear to be reasonable.[58] This naturally effects the completion time of the structures, with 32 men able to complete MCs 47, 48 and 52 in 301.90 days, 300.40 days and 318.25 days respectively. The fact that these estimates all take more than one building season highlight just how unique to the Wall these structures were. Whilst other structures derived from a need to be built by an army campaigning in the field, and were therefore dictated somewhat by available labour, the milecastle could clearly take advantage of the nature of the Wall project in a preexisting province.

How do these figures compare with the theoretical maximum number of people that could work on the site? In order for this to have any relevance the numbers need to be at least smaller. Table 6.10, below, shows the maximum number of people who could work efficiently on site, and the fastest possible completion time:[59]

Table 6.10			
Type	Average Area	Max. on Site	Max. Completion Time
SW Milecastles	397.86m^2	29 persons	219.28 days
TW Milecastles (Turf)	782.01m^2	56 persons	76.26 days
TW Milecastles (Stone)	609.22m^2	44 persons	161.27 days

Table 6.10: Maximum persons on site, and maximum completion times for milecastles.

Importantly, the theoretical garrison of 16 is below the maximum efficiency figure. It must be stressed this merely

[57] Daniels, 1978, 193.
[58] Dobson, 1986, 13; Breeze, 2006b, 66.
[59] In line with the project methodology, §4.8.3, and Shirley, 2000, 92.

means that the theory is a possibility, rather than confirming its use in practice. Most importantly, with the abnormally large examples of MC47 and MC48, the proposed 32 man garrison does not exceed the maximum number of efficient workers on site of 35.71 and 36.58 people respectively.

§ 6.4.2 | The Symbolism of Milecastles

First and foremost it is important to note that the towers of the milecastles provide many of the symbolic benefits which the turrets possessed. The effect of having such repetition of symbolism on more than one interval structure would have made avoiding the many symbolic messages and allusions an impossibility and provide a consistency of messages right across the length of the Wall. However, the milecastles' anatomy and purpose provide far greater symbolic potential than that of the turrets. Firstly, their use in allowing people to move across the Wall-complex is important. Their use in housing soldiers in barracks, and potentially towers, provided further layers of symbolic potential.

Traditionally, the role of the milecastles has been emphasised in terms of either providing a scouting force which could operate in intelligence gathering to the immediate north of the Wall,[60] or as a Roman-era 'Checkpoint Charlie' controlling the flow of people and also goods into the province.[61] The link between the *portoria*, the Roman enforcement of customs and tolls, and the military in many areas of the empire provides a parallel for the Wall's use as a customs barrier.[62] This theory as the raison d'être of the Wall is compelling as it appears to answer many of the criticisms levelled at overly military interpretations: the lack of evidence for a fighting platform across the curtain and the low density of soldiers present

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[60] Donaldson, 1988, 134-5; Mann, 1990, 53. Dobson, 1986, 12, however proposes: 'Patrolling must have been the responsibility of the men in the forts, as the soldiers in the milecastles […] would have sufficient to do to guard the gates and man the presumed towers.'

[61] Birley, 1956, 25-33; Dobson, 1986, 24.

[62] Kerr, 1989, 442; Elton, 1996, 88.

on the Wall, for example, as well as the undersupply of turrets.[63] Similarly, the army in this period is interpreted to have fought by meeting opponents in the field and not from behind walls.[64]

However, as noted previously,[65] considering the Wall solely in terms of a customs barrier ignores the important role which control of money plays in the Roman world. Consequently, function must be extracted from reason: undoubtedly, the milecastles function in order to allow the Wall to be crossed. Their purpose, however, is connected to the broader aims of the Roman army. The potential use of the Wall to collect taxes, be they monetary or perhaps as a proportion of the goods being carried through a milecastle, was an expression of *maiestas* on a personal level, and clear indicator of the status of the Roman state as it maintained this right of excise. In this way the economic is used to emphasise discrepant power and mediate status. The fact that this took place physically on the Wall together with the provision of so many sites at which these actions could have taken place is a key component and would have imbued the Wall with the symbolism of dominance.

The amount of effort required to construct a structure also had symbolic associations. Large scale structures connoted vast cost, in both labour and fiscal terms, and thus their physical presence attests and gives tangible form to the seemingly limitless power at the command of Hadrian and Rome. That the Wall was involved in contributing resources and money provided a circular relationship which further emphasised this powerful facet and the Roman state's

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[63] Caes. *B Gall.* V.40 records Cicero erecting 120 towers to defend his camp: 'During the night as many as 120 towers were raised with incredible dispatch out of the timber which they had collected for the purpose of fortification.' Noctu ex materia, quam munitionis causa comportaverant, turres admodum CXX excitantur incredibili celeritate; quae deesse operi videbantur, perficiuntur. Dobson, 1986, 7.

[64] Dobson, 1986, 21-5. Indeed, fighting forces of units smaller than cohort size are unattested, thus the use of milecastles in such operations by design can be doubted. Frontin. *Str.* 2.VI uses examples to illustrate the tactical preference for combat in the field in a work compiled in the late-1st century; Veg. *Mil.* book III contains information on strategy and tactics, 3.13 discusses the ideal place for battle and makes no mention of static defence. Similarly 3.20 lists viable tactics during combat, none of which involved combat from behind walls.

[65] §3.2.

Fig. 6.7: Left, arch of the Temple of Hadrian at Ephesus. Right Hadrianic coin from Bizya with arched city gate.

maiestas. However, it was not simply the act of taxation which provided an opportunity for 'the maximization of magical profit'.[66] The entire structure of the milecastle, as well as the acts which took place within, are predicated upon the premise of *maiestas*. The materials from which the structures were made was symbolically charged. The stone wall, and naturally the stone rebuild west of the Irthing, provided a space for *Terminus*, a god of boundary who could reside in any stonework.[67] His presence would serve to emphasise the fact that this was Roman space and sheer proximity to the structure of the Wall would expose someone to this religious power.

The act of passage added an extra layer of symbolism connected with gateways, thresholds and, importantly, arches. Arches and gateways are used to control and condition all who use them,[68] and each part of a gateway; the vault, imposts, hinges, panels and the threshold itself; were under the charge of a separate deity. Carna/ Cardea, for example, had power over door hinges and handles. The gate personified can be seen in the form of Janus, and the gates themselves were thus a 'forbidden tract of earth charged with menacing power'.[69] Thus passing through the gateway was an act that would place someone at the mercy of a whole array of Roman deities that were present because the Romans had provided the

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[66] Bourdieu, 1990, 228.

[67] This boundary should not be taken literally, as the boundary of the Roman empire. Terminus could be seen demarcating field boundaries, for example. Rykwert, 1976, 62, 107.

[68] Henderson, 2003, 240.

[69] Rykwert, 1976, 136.

Fig. 6.8: City wall and gate headdress of Antioch's Tyche.

space in which they resided. Similarly, the milecastle gateways, with their non-functional piers emphasised the act of passage and clearly highlighted the power of Rome.

As with the stone built nature of the gate reifying esoteric concepts, so too the very shape of the gateway. The vault itself is an integral part of religious architecture, natural or artificial vaults were long recognised as the conventional setting for many cults, thus arches were associated with religious sanctity.[70] Hadrian's temple at Ephesus is one such example, shown on Figure 6.7. Despite these religious connotations, the emperor was not exempt from these chains of association. The archway created by the arcuated lintel was a common characteristic of public munificence which was often connected to the emperor through patronage.[71] Consequently, the emperor's connexion to the structure can again be subtly seen. Furthermore, gates themselves were traditionally under the jurisdiction of the civil, rather than the sacred, due to the nature of the consecration ceremonies.[72] It is perhaps possible to venture that this may have subtly implied the subordination of the power of gods to that of the emperor.

Gateways, alongside city walls, were key components of cities and civic identity. The gateway provides a natural point of focus and entwines with the city walls to form a visual 'shorthand' of civic ideals.[73] This can be seen on Figure 6.8, in the use of walls and gates as headdresses for personifications of place, and on Figure 6.7 as the city of Bizya in Thrace is characterised solely by its gates and walls. Whilst many of these factors connect to power displays, the ordering of space and subordination to the Roman; there are

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[70] Thomas, 2007, 58, 60.
[71] Thomas, 2007, 65.
[72] Rykwert, 1976, 65.
[73] Thomas, 2007, 111.

messages of unity involved in the archway and thus the act of passage. The architectural form of the archway, with voussoirs coming together from separate imposts, serves as a visual metaphor for unity.[74] However, whilst this message of amalgamation and integration may be a departure from the standard themes of power and subordination, it is clear that this harmony can only be reached through submission to the Roman. That a traveller was placed physically beneath reifications of Roman gods, Terminus and Janus for example, and the emperor highlighted the message that accord could only be achieved by accepting Roman rule and its ordering of space. The archway, in effect, issues the terms of concord, and its use is one of the conditions of peace.[75]

These diverse and varied messages are communicated during the act of crossing, movement here serving to modify both perceptions of structures and material culture as well as social relations.[76] However, once the act of entry is complete it leads into the interior of the milecastle. This, combined with the use of the gateway, gives the milecastle power beyond that of the towers as *praxis* becomes an active factor with the structure. Furthermore, travelling through the milecastle would provide exposure to Roman 'residential' space, and not just the monumental space that the rest of the Wall espoused. The day-to-day activities of the Roman soldiery, the making of food, the maintenance of equipment and even the playing of games[77] would have introduced an extra symbolic dimension to the structure. Undoubtedly power was represented again with both the enforced exposure to Roman 'residential' and monumental space and the presence of the soldiery added an element of

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[74] Thomas, 2007, 83 discusses Herodes' use of the archway to represent 'immortal concord'. There was a philosophical connexion between stoic harmony and the voussoirs of an arch.
[75] Henderson, 2003, 240.
[76] Moatti, 2006, 110.
[77] Allason-Jones, 1988, 218, notes the discovery of gaming boards indicated a large amount of 'down time' at many sites.

Fig. 6.9: Ethnic units reconstructed from Trajan's Column.

surveillance.[78] Furthermore, the familiar tropes of where and how someone lives are subverted into the Roman styles, not those of the indigenous populations. Whilst this seems a clear point, that the Romans would order space differently, it is the use of familiar sights, such as a residence, that are used to highlight differences and thus be used in the mediation of discrepant power relations.[79]

This control of space, and the responses available within, is directly connected to the broader control of behaviour.[80] This fact allows taxation to be gathered and converted in to *maiestas*. The fact that this act was carried out by the soldiers further reified the abstract presence of the emperor through the chain of connexions outlined for the turrets.[81] That these self same units came from all over the Roman world granted a powerful propaganda demonstration of disparate people living in harmony under Roman rule. This emphasised one of the archways symbolic messages, that concord was possible under the Roman ordering of space. This represents a similar visual metaphor shown through the use of soldiery from around the Roman world on Trajan's Column, reconstructed on Figure 6.9.[82] The propaganda message is connected to vast groups responding, all united under Roman auspices. This is the praxis based equivalent, with the same underlying principles.

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[78] Fredrick, 2003, 209. Carl *et al*., 2000, 347, notes that cities were organised to allow the divine to gaze upon the public spaces. The limited anatomy and scale of the milecastles allow this to take place on the Wall.

[79] Fredrick, 2003, 213. This aspect, perhaps more than any other, relies on the comprehension of the viewer.

[80] Boyle, 2003, 35.

[81] §6.3.2.

[82] Also see Rossi, 1974, 66, Fig.26 and §3.4.1.

Finally, the potential of the milecastles to have a second tower allows for the effective restatement of the case of the gateway. This repeated symbolic emphasis on Roman majesty is remade and restated with every journey through the Wall, and under every Roman built archway administered by the soldiers. This is restated repeatedly due to the fact that the link between emperor and Wall is an abstraction. Thus the proposition that the object, the Wall, is bound to a concrete signifier, the emperor, his *maiestas* and that of the Roman state, needs to be continuously re-staged through the structure and the processes which take place within and around.[83]

§ 6.5 | Forts

The forts are the Wall's largest interval structures and, as such, have attracted much discussion and investigation. However, due to the vagaries of the archaeological record, this has not resulted in a total understanding of every fort along the line of the Wall. The depth of knowledge on which Shirley's study of Inchtuthil is based is not possible with the forts of Hadrian's Wall. As a consequence assumptions have to be made regarding the anatomy of some individual fort sites. The turrets which flank the gates of each fort share many unknown characteristics with the interval turrets along the curtain. Consequently the same methodology will be applied to the height of fort turrets as to their stand-alone counterparts. Again, tapered upper floors of 0.45m are presumed. A wall height of 4.2m is used, this figure is context specific to the forts of the Wall, deriving from a projected stone staircase intersecting with the fort wall of Housesteads.[84] The ground plans of fort turrets do not always survive in detail, if at all. Consequently, an average of all known fort turrets are used as a proxy of the missing structures. This is summarised on Table 6.11 showing the number of presumed towers for each fort surveyed and the number needing to be averaged.

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[83] Gunderson, 2003, 658.
[84] Crow, 1995, 30.

Table 6.11			
Fort	Presumed Turrets	Known Turrets	Averaged Turrets
Wallsend	16	All except West gateway	2
Benwell	12	SE angle	11
Rudchester	12	South and West gateway	8
Halton Chesters	12	West gateway, N; East gateway, N	10
Chesters	20	South, North, West gateway; SE angle SW and SE interval	11
Carrawburgh	14	None	14
Housesteads	20	All gateways; all angle; EN interval, S interval.	6
Great Chesters	12	West gateway, South gateway E; NW and SW angle	7
Birdoswald	14	East, South, West gateway; all angle; all interval	2
Castlesteads	12	West gateway, S	11
Stanwix	12	None	12
Bowness-on-Solway	12	W gateway, N.	11

Table. 6.11: Number of fort turrets surveyed, and number averaged.

At this juncture the limits of the study must be stressed. As noted, it is not possible to execute the kind of study Shirley performs on Inchtuthil. Often the details of sites are not recoverable due to their locations under modern settlements. Similarly, they may not have experienced full layer-by-layer excavation, making the exact knowledge of their internal anatomy impossible to quantify. Consequently, this study will project outwards from the most commonly gathered information. Much work in the antiquarian period was directed to finding the extent of the forts rather than their internal layouts. This necessitated the location and measurement of the fort's walls. Similarly, much interest was concentrated on the gateways and their attached towers, with internal structure only rising to prominence from the mid-19th century.[85] This has led to a disproportionate understanding of the walls of forts and their interval structures when compared to the internal anatomy.

Taking this as a basis, and comparing the forts of Hadrian's Wall with Shirley's work at Inchtuthil, it is possible to see that work on the walls and towers of a fort comprises some 17% of the total labour demand of a fort.[86] Consequently, the figures generated here will be 'scaled up' from the 17% which they represent to provide an estimate of the labour requirement of a full fort. This inflation applies to the stone volume and the number of person days required. It is not applied to the turf volume of the stone forts as this represents the rampart backing of the fort's stone walls. This would not have increased in Hadrianic forts as their internal buildings were almost exclusively stone.[87] Clearly, these projections cannot, by definition, be as accurate as Shirley's in-depth study; nevertheless, they provide the best method for generating the data required and this methodology is applied consistently across the whole sample group, rendering comparisons valid.

There are caveats to be applied to this method. Constructed in the A.D. 80s, Inchtuthil was an admixture of stone as well as turf and timber structures; and as a legionary fortress it was also notably larger than an auxiliary fort. This would mean that, as the length of rampart wall decreased and thus the area for structures inside the fort was reduced, the relative importance of the rampart wall would be increased. However, this is balanced by the use of stone structures in Hadrianic-era forts and fortresses compared to timber structures from Trajanic and earlier forts. The two/three times cost increase in internal structures roughly balances out the similar reduction in rampart wall length. Clearly this limits the application of

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[85] Hill, 2004, 1-2. Rudchester's 1924 excavations, for example, concentrated on the gates and the *praetorium*. Brewis, 1925, 93-120; Breeze, 2006b, 169.

[86] For a percentage break-down of Inchtuthil's labour see Shirley, 2000, 155. This study includes extramural features (2%), on-site preparation (1%) and stonework structures (14%).

[87] Hanson, 1996, 354.

the methodology to sites similar in size to forts and fortresses. A similar ratio could not, for example, be applied to a milecastle.

§ 6.5.2 | Forts: Quantitative Results

Table 6.12 shows the results of the quantitative survey in terms of labour demand and cost using the 'Inchtuthil ratio' totals. The turrets of the forts are assumed to be Type I. Once again the results are broken down into the original stone Wall, the Wall west of the Irthing and the stone rebuild of the turf sites.[88] It must be noted that this turf group numbers just one fort, this is assumed to be a Type I turf and timber fort, in line with the project methodology.

Table 6.12			
Group	Full Work Rate	Full Cost	Standard Deviation
SW Forts	112,431.11 person days	£32,474,776.36	12,907.16 (11.13%)
TW Fort	65,376.97 person days	£9,700,701.61	n/a
TW Rebuild	120,836.86 person days	£33,252,916.23	10,481.19 (8.67%)

Table. 6.12: Fort groups, average labour demand, cost and standard deviation.

There is a relative uniformity between the forts in the east, and the stone rebuilds in the west. Whereas the milecastles show distinct differences from their eastern counterparts when they are rebuilt in stone, the forts show a mere 2% difference in terms of labour demand and cost. The stone forts as a whole are remarkably uniform, deviating by less than 10%.[89] This is not entirely surprising as the milecastles seem to react to local factors, which can be seen in the abnormally large examples of MC47 and 48. This is not the case for the forts, which are a standard part of Roman structural vocabulary seen throughout the Roman world.

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[88] For quantitative survey see §A2.40-7 for stone wall forts, §A2.48-50 for turf wall forts and §A2.51-5 for stone rebuilds.

[89] Exact deviation 9.87%.

The results in terms of labour and cost for each fort within the sample group are shown on Table 6.13. Type I structures are assumed throughout, wherever applicable.

Table 6.13			
Group	Fort	Full Work Rate	Full Cost
SW Forts	Wallsend	122,891.88 person days	£35,417,576.37
	Benwell	111,656.04 person days	£32,329,578.13
	Rudchester	101,706.25 person days	£29,422,432.63
	Halton Chesters	117,880.06 person days	£34,115,682.24
	Chesters	133,386.21 person days	£38,473,878.47
	Housesteads	118,098.62 person days	£34,051,711.49
	Great Chesters	112,073.17 person days	£32,467,173.67
TW Fort	Drumburgh	65,376.97 person days	£9,700,701.61
TW Rebuild	Stanwix	144,801.87 person days	£39,774,650.78
	Bowness	119,535.95 person days	£33,045,855.11
	Castlesteads (i)	109,324.55 person days	£29,864,134.54
	Castlesteads (ii)	102,458.13 person days	£28,016,859.73
	Birdoswald	128,063.80 person days	£35,563,080.98

Table. 6.13: Labour and cost of individual forts.

As can be seen, the broad correlation in size between the stone-built forts of the Wall is even more evident when viewed individually. Similarly, the high cost and labour demand shown by the use of stone is underlined by the disparity between the sole surviving turf structure. Drumburgh demands *circa* half the labour of the stone forts and less than one third the cost.

The quantitative survey also allows specific questions to be answered. Table 6.13 shows two projections of the shape and size of Castlesteads fort. The site's excavators proposed:[90] option I, an east-west axis fort; option II, a square fort. The surviving extent of

[90] Richmond & Hodgson, 1934, 161-2. The present author uses the terms 'I' and 'II' to differentiate between the projections.

the fort is shown on Figure 6.10. There is little difference between the two projections, yet the first option is closer to the average of the group and may well be the more likely orientation of the fort. Similarly, there is some discussion about the exact form of turf and timber forts. This relates to the top width of the trapezoids which formed the ramparts of such forts. As noted in §4.6.1, this can be either 3m wide, a Type II structure; or a more conservative 1.8m, referred to as a Type I structure. Table 6.14 shows a comparison of Drumburgh's rampart as a Type I and II structure:

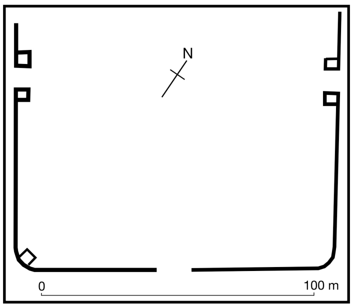

Fig. 6.10: Surviving extent of Castlesteads.

Table 6.14			
Drumburgh Feature	Type I	Type II	Difference
Volume	5,130.13 m^3	5,941.21 m^3	15.81%
Number of Turves	171,004.22	198,040.46	15.81%
Turf Cutting	3,866.46 person days	4,500.92 person days	16.41%
Haulage	790.37 person days	915.33 person days	15.81%
Laying	3,866.46 person days	4,500.92 person days	16.41%
Core Haulage	395.18 person days	457.66 person days	15.81%
Parapet	109.16 person days	111.18 person days	1.85%
Rampart	123.94 person days	356.78 person days	187.87%
Total Work Rate	11,080.84 person days	12,732.06 person days	14.90%
Completion Time	11.08 days	12.73 days	14.89%

Table. 6.14: Difference between Type I and II turf structures at Drumburgh fort.

A large disparity between Type I and Type II structures in terms of percentage can be observed. There is a *c*.800m^3 difference in volume between the two types of ramparts, amounting to *c*. 25,000 turves. Is collecting the extra resources required for a Type II structure practical? The Lunt reconstruction had a top width of c. 2m,[91] close to that of a Type I structures, which created a rampart

[91] Hobley, 1967, 87; *Id*., 1982, 228

that required the use of the land around the fort up to 38.1m away.[92] Experimental archaeology has shown that carrying turves over a distance greater than 50m would greatly increase the chance of breakages.[93] The addition of the extra width created a need for 15.81% more turves, increasing the land needed around the fort by 5.72m to 43.82m. Thus the total is still well below the 50m mark, consequently Type II structures are a realistic prospect.

Workrate related to the rampart is where the main increases in demand can be noted. Haulage and the laying of turves shows an increase of some 650 person days. Core haulage is increased by around 60 person days and there is a nominal increase in the amount of work for the parapet, *c*.2 person days. The laying of the woodwork on the rampart walk shows the largest increase, this is hardly surprising as this area is most affected by the increase in top width. This complex task is the most vulnerable to an increase in top width. As can be seen, there is a net increase of c.1,600 person days, a figure which appears substantial but with a garrison of 1,000 men this would have involved an increase in real time of less than two days, not a great amount.

Consequently, it is possible to conclude from this comparative case-study that, whilst a structure with a top-width of 1.8m would provide relatively large percentage savings in terms of materials, the actual real-world effect of this saving would be minimal. However, it must be noted, this is assuming that the full garrison of the fort could work on the site; were manpower restricted for some reason, or materials limited, the use of the smaller Type I rampart would be preferable. This is best highlighted with the amount of time it would take to complete the rampart, with the Type II taking almost three times as long to be finished. Without a large number of workers to ameliorate this variance, the difference in completion time would be quite pronounced.

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92 Hobley, 1967, 88.

93 Hobley, 1967, 88; Jones, 1975, 30. Breakages could form the rampart core.

Indeed, completion times for the forts are one of the most interesting issues arising from this analysis. Unlike the milecastles and turrets, forts are the primary structures in which units reside. Table 6.15 compares the two separate Inchtuthil derived methodologies: the first is based on the garrison being able to work on the site; the second is that of one person needing a minimum of *c*.14m^2 space. The 'Difference' column shows the number of days difference between these two measures.[94]

Table 6.15						
Group	Fort	Garrison	Completion with Garrison	Max. on Site	Max. Completion	Difference
SW Forts	Wallsend	608	202.12 days	1,246.95	98.55 days	-103.57
	Benwell	512	218.08 days	1,683.37	66.33 days	-151.75
	Rudchester	608	167.28 days	1,375.97	73.92 days	-93.36
	Halton Chesters	608	193.88 days	1,324.61	88.99 days	-104.89
	Chesters	500	266.77 days	1,743.98	76.48 days	-190.29
	Housesteads	800	147.62 days	1,541.37	76.62 days	-71.00
	Great Chesters	480	233.49 days	1,730.01	64.78 days	-168.71
TW Fort	Drumburgh	1,000	65.38 days	566.17	115.47 days	+50.09
TW Rebuild	Stanwix	768	188.54 days	2,647.67	54.69 days	-133.85
	Bowness	1,056	113.20 days	1,824.00	65.54 days	-47.66
	Castlesteads (i)	480	227.76 days	1,234.10	88.59 days	-139.17
	Castlesteads (ii)	480	213.45 days	1,030.11	99.46 days	-113.99
	Birdoswald	480	266.80 days	1,608.51	79.62 days	-187.18

Table 6.15: Completion time of forts by garrison and maximum persons on site.

As can be clearly seen, in almost all cases the number of people within the garrison is far below the theoretical maximum that could fit on site and still work efficiently. This means that, whilst forts may well be designed to be completed by the garrison in one building season, a fact reinforced by the *circa* 200-day results

[94] See §4.8.3; Shirley, 2000, 92.

here, they could be built a great deal more quickly by the assignment of extra work gangs. This demonstrates the flexibility inherent in the Roman system, and further emphasises how the design and the reality on the ground could differ markedly.

The results for Drumburgh, the only turf and timber fort surveyed, show this to be the only fort where the maximum on site was lower than the garrison. Almost half the soldiers, 434, would have been unable to contribute without affecting productivity and efficiency. As a consequence, Drumburgh's completion time is altered to the lower figure of 115.47 days. It should be noted that this is in line with stone forts such as Bowness, Housesteads and Rudchester on the Wall, and is a reflexion of the lower labour demands exerted by turf and timber structures.

§ 6.5.3 | The Symbolism of Forts

Forts pose the most interesting symbolic questions of all the Wall structures. It is not only the case that forts brought an extra function to the Wall, since they were later additions, but that they were a structure seen all around the Roman world which therefore drew upon pre-existing symbolic meanings. This is profoundly different from both the milecastles and the isolated turrets in that forts were not Wall specific. Whilst it is true to say that turrets and milecastles did not develop in a vacuum, their close integration with the curtain wall is unparalleled elsewhere in the Roman world and means that their symbolic message is unique in this period. What does the standard design of the forts bring to the Wall, and how is it changed by their integration into its structure?

Firstly, it is important to note the features which the forts possess. Towers, for example, can be connected to the turrets of the Wall, thus providing a continuity in terms of symbolic message. Similarly, the gateways of milecastles and those of the forts are analogous. Indeed, the forts may have even more prominent associations due to the use of twin-portal gateways, compared to milecastles' single portal examples.[95] Importantly, there is no reason why forts could not be a site of passage as well as the milecastles. This is emphasised with the location of some forts, Great Chesters overlies MC43 for example. The use of the structure laid bare the different symbolic and *praxis* messages of the forts' interiors.

The forts themselves, as with all built places in the Roman world were divinely ordered. In this case, the same rituals and principles seen during the foundation of cities also occurred to military camps.[96] The city, and thus the military camp or fort, is connected to the creation of a new god of place.[97] The emperor is immanent amongst this, his presence through the imperial cult placed him not only on the line of the Wall but as one of the key deities for an area. The creation of new gods of place combined with the introduction of the emperor makes the inclusion of forts along the line of the Wall commensurate with the monumental aspects discussed above, that is, the tendency to overwhelm, rather than emphasise, the pre-existing ordering of the landscape. This connexion to the city renders a more real representation of Roman urbanity than that reified in the milecastles. Importantly, the forts all have accompanying settlements, with incentives offered to encourage the populace, both 'Roman' and 'other', to reside in the *vici*.[98] Whilst it took until the 3rd century A.D. for these civilian settlements to reach their peak, it is clear that such incentives imply an intentionality behind the role of the forts to promote economic and social change.

There were key differences between a fort and a Roman city. Whilst both of these were divinely constituted, a fort lacked public buildings and the organs of civil government. Consequently, the 'corporate identity' which the walls of a city projected would have been

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[95] It must be noted that, later on, forts gain emphasised entrances, such as the type seen at Risingham.

[96] Rykwert, 1976, 46, 48, 68-9; Carl *et al.*, 2000, 334. Vitruvius considers cities and military camps as alike: 'Our ancestors when about to build a town or an army post […]'. Maiores enim pecoribus immolatis, quae pascebantur in is locis, quibus aut oppida aut castra stativa constituebantur […], Vit. *De Arch*, I.IV.9.

[97] Rykwert, 1976, 89.

[98] Jones & Walker, 1983, 190; Higham, 1989, 155.

different from that of a fort. The existence of the *vici* in this case is vital for providing a 'civilian' element to the symbolism. Similarly the aristocratic commander who could be found at legionary fortresses gave the site a tangible connexion back to Rome. Consequently the symbolism of fort walls should not be seen as mutually exclusive from those of the city, but as a subtly different admixture of features with an alternative emphasis.

What are the reified concepts of the city seen with both forts and *vici*? The walls surrounding the camp were, most importantly, not intended primarily for defence, they were constructed for aesthetic and non-material reasons.[99] Chief amongst these was the embodiment of the city. Forts had the key external features of a Roman city, gateways, towers and walls. The ditches built around forts provided an element of the sacred and unity for that which was enclosed.[100] Furthermore, the ditches served to redefine space without distracting from the main point of focus, the fort walls, gates and towers.[101] As with milecastles, the act of crossing was important as the multiple gateways provided for this action. Combined with their placement over milecastle sites it is clear that the forts were not just used by the military, but also fulfilled similar roles to those executed in the milecastles. Crossing and passage was of importance and, once again, associations between boundaries and the sacred were structurally part of the fort ditches.[102] The act of crossing forced tacit acceptance of Roman legitimacy and their ordering of space.[103] The walls themselves were divinely charged and considered sacred.[104] Their material allowed Terminus to reside within, furthermore, the similar traditions

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[99] Carl *et al*., 2000, 346. Similarly, city walls in Gaul may not have been primarily defensive, Whittaker, 1997, 144-5. There were occasions where Roman forts were besieged, during the Batavian revolt for example, so it is clear that they could operate defensively when required.

[100] Rykwert, 1976, 134.

[101] Evans, 1988, 92; Thomas, 2007, 110.

[102] Evans, 1988, 92-3.

[103] Rykwert, 1976, 134. Earthworks, for example sacred ploughing, were connected to the laws of Roman space. E.g. the inviolability of the *pomerium*.

[104] Rykwert, 1976, 28.

to city foundation meant that military camps and forts were not simply places to rest, but were very real extensions of the *imperium* and *maiestas* of the Roman state.[105]

Due to the sacred nature of the fort walls and ditches and the presence of deities, the walls themselves provide a ritual, sanctified enclosure within which space could be given an overall unity.[106] This unity meant that those passing through would be exposed to the Roman ordering of civic space as well as the reification of the Roman people and the institution of the military.[107] The rigid regularity of the fort plan, the hierarchy of the structures, the methods of moving around the fort itself and the highly visible presence of soldiery all demonstrated the Roman concept of space and the joint root of forts and cities in their cosmological, sacred, origins. The connexion between the layout and the cosmological, as well as the availability of the space to be surveilled, provide yet more tangible examples of an area ripe for use in 'magical conversion'. Similarly, the many different points of access and egress from the structure provide for the repeated statement of the case of Roman power, in a similar nature to the two towers of the milecastles. Finally, the message of overwhelming power is provided by the daunting size of the structure to which the forts are connected and the sheer amount of space available within the fort and around it between ditch and vallum.[108]

§ 6.6 | The Curtain Wall

The curtain itself is the primary characterising structure of Hadrian's Wall, yet there is much debate to the purpose it served. Indeed, in a discussion of the curtain, it is worthwhile examining what it is not. The curtain has been subject to much retrojection primarily inspired

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[105] Rykwert, 1976, 57, 68.

[106] Rykwert, 1976, 62, 135; Thomas, 2007, 113.

[107] Thomas, 2007, 147. Gell. *NA* 16.13.9: [*Colonia* are seen as] pre-eminent because of the scale and majesty of the Roman people, of which these colonies seem to be almost small likenesses and representations […]'.

[108] Thomas, 2007, 114.

by modern geographically and topographically 'correct' maps providing the modern observer with tools and concepts that were simply not available in the Roman era.[109] This, combined with modern interpretations of military structures have led to the idea that the curtain wall was the physical manifestation of the boundary of the empire. Whilst the military interpretation of Roman structures is discussed elsewhere[110] the idea of the 'limit of empire' needs to be discussed.

Boundaries in the Roman world were not viewed in the manner with which the modern observer is familiar. In the Roman era they were non-geographic with people disconnected from the land they occupied,[111] it was the groups of people themselves that were conceptually important, not their territory.[112] It is for this reason that revolts are considered foreign, and not civil, wars. Conquered people became Roman by accepting Roman power and their ordering of space.[113] When they cast off the trappings of, and subservience to, Rome they cease to be seen as Roman, even if their land was in Roman hands.[114] The view, therefore, of the curtain as a hard-and-fast demarcation barrier of Roman from 'other' is a modern concept, influenced, by modern mapping and the modern conflation of people to land.[115] Furthermore, the curtain's role in defining Hadrian's Wall can be brought into question. Itineraries give a vital insight into how space and place was conceptualised by the Romans. Trajan's itineraries, relating to his Dacian campaigns against Decabalus, gave the distances between key stops;[116]

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109 Dilke, 1985; Isaac, 1992, 406; Austin & Rankov, 1995, Chp.5; Mattern, 1999, 24, 26. See §3.2. For examples of such use see Luttwak, 1976, 107; Hodgson, 2000.

110 See §2.4.

111 Isaac, 1992, 396-7.

112 Laurence, 2001, 72; Isaac, 1992, 406.

113 It must be noted that these are Roman values. Conflicts can occur when core values overlap. The example of language in Achaea is apt, and accounts for the low Latin uptake. See Woolf, 1994, *passim*.

114 Mattern, 1999, 5.

115 Mattern, 1999, 25. See §2.2.1 for uncritical use of the *SHA*.

116 Mattern, 1999, 28. Interestingly, triumphs appear to show this as well with their record of places conquered being represented in a linear manner. *Ibid*., 166.

similarly, the Antonine Itinerary forms a list of key places not couched in terms of geography and locations.[117] Rather, it is seen as a series of point-to-point sites which allow travel from one to another.[118] This places emphasis upon the roads used to travel between the sites, as well as the sites themselves, rather than the geography of placement within the landscape. Fundamentally, this is a linear conception of space rather than the holistic 'bird's eye' perspective the modern observer can draw upon.

Given that the line of forts on Hadrian's Wall forms an east-west lateral group, it is this arrangement which is important, and not the blocking of movement along the north-south, something which the milecastles, with their gateways, go to great lengths to avoid. The emphasis on the forts is perhaps reinforced by the *De Rebus Bellicis*, which, when discussing frontier defences, makes no mention of the curtain linking the interval structures.[119] It is the concept of the line of forts and the connexions between them, rather than a continuous barrier, that is the identifying feature of Hadrian's Wall.[120]

This poses an interesting question: if chains of sites, and their interconnectedness is key, why was there no lateral road connecting all the sites? Indeed, aside from the Stanegate serving the central area, there is little evidence for roads connecting forts from Wallsend to Halton Chesters, and from Bowness to Stanwix. Road building is often connected to civic wall construction under the guise of imperial benefaction. This can be seen at a variety of places including Saepinum, Fanum Fortunae, Ravenna and Laus

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[117] Laurence, 2001, 75.

[118] Mattern 1999, 25; Laurence, 2001, 75; Broderson, 2001, 18-9.

[119] Johnson, 1979, 63. *DRB*, XX: 'an unbroken chain of forts will best assure the protection of these frontiers, on the plan that they should be built at intervals of one mile, with a solid wall and very strong towers'. 'limitum […] quorum tutelae assidua melius castella prospicient, ita ut millenis interiecta passibus stabili muro et firmissimus turribus erigantur.' *Limites* is in accordance with the meaning of the time: frontier districts. Isaac, 1988, 128; *Id*., 1992, 412.

[120] Laurence, 2001, 72. The *pomerium* is key here, as is the concept of other settlements being like Graeco-Roman models, e.g. Ptolemy's *poleis* in Britain.

Pompeia.[121] It is in this context that the Wall should be viewed, as a connected expression of Imperial largesse which serves to connect the Wall to the emperor in a very real manner. This key point will be considered during the discussion of the curtain's symbolic meaning. Having seen how the curtain does not serve as a boundary marker, what does the quantitative survey say about the structure?

§ 6.6.1 | Curtain Quantitative Survey

The curtain is not uniform along its length, to the west of the Irthing it was originally rendered in turf. However, evidence survives sparingly, thus the limited turf information is applied across the whole length of the turf curtain. The dimensions of the stone curtain also differ across different wall-miles, and, importantly, between those sections built before and after the decision to integrate forts to the line. The differences in each section are summarised on Table 6.16:[122]

Table 6.16		
Curtain Zone	Foundation Width	Superstructure Width
Segedunum - 4	2.5m	2.29m
4 - 22	2.97m	2.86m
22 - 27	3.43m	3m
22 - 27	3.43m	1.83m
N.Tyne - T45a	3.15m	2.21m
Mile 48	3.15m	2.74/2.21m
45a - Irthing (ex 48)	3.15m	2.74m
Turf Wall	6m	1.8m
49-54 (Rebuild)	2.59m	2.29m
54-80 (Rebuild)	2.74m	2.67m

Table. 6.16: Anatomy of the stone curtain.

[121] Jouffrey, 1986, 63-6 in Lomas, 1998, 71.

[122] For the turf wall, the superstructure width represents the top width of the trapezoid that is required to construct turf ramparts. See §4.6.1 and Fig.4.1 for more. For stone curtain survey see §A2.2-3, for turf see §A2.4-5, for stone rebuild see §A2.6-7.

Firstly, the turf wall's top width is presumed to be 1.8m. Primarily, this is in line with the project methodology of using the smaller figures, it also allows an expansion of the discussion accompanying Table 6.13. A fort is a relatively small scale structure in comparison to the curtain, the conclusion derived from the fort may not be applicable to that of a much larger structure. The difference between a turf wall with a top width of 1.8m and with 3m is shown on Table 6.17:

Table 6.17			
Turf Wall Feature	Type I	Type II	Difference
Volume	778,278.70 m^3	898,013.88 m^3	15.38%
Number of Turves	25,942,623.20	29,933,796.00	15.38%
Turf Cutting	589,605.07 person days	680,313.54 person days	15.38%
Haulage	119,904.90 person days	138,351.80 person days	15.38%
Laying	589,605.07 person days	680,313.54 person days	15.38%
Core Haulage	59,952.45 person days	69,175.90 person days	15.38%
Parapet	16,333.27 person days	16,630.98 person days	1.82%
Rampart	18,509.06 person days	53,282.16 person days	187.87%
Total Work Rate	1,393,909.82 person days	1,638,067.93 person days	17.52%
Completion Time	464.64 days	546.02 days	17.52%

Table. 6.17: Difference between Type I and II turf and timber ramparts for the turf curtain.

Here the completion time is the key, with an arbitrary figure of 3,000 men, or half a legion,[123] involved in the construction, building to a Type II top width adds an extra 81 days. This is approaching half a building season and represents a not inconsiderable investment in time. Again, this highlights the variability in Roman building, with Type II structures being a viable prospect on smaller structures, yet prohibitively costly in terms of labour demand for larger scale structures. Indeed, this stress on variability in structures, seen both in the stone wall's superstructure and interval structures themselves, means that there may not have

[123] Shirley, 2000, 92.

been a designated size and that ramparts would be altered within workable parameters based upon available labour and resources. It is possible to conjecture that, given the emphasis on the importance of effort of construction,[124] that it was symbolically worthwhile building the more time-consuming structure.

The results of the quantitative survey of the curtain wall can be seen below, on Table 6.18:

Table 6.18		
Curtain Zone	Work Rate	Cost
Segedunum - 4	173,967.72 person days	£50,495,794.18
4 - 22	1,054,708.71 person days	£305,316,960.10
22 - 27	159,528.24 person days	£46,180,216.93
22 - 27	100,843.60 person days	£29,270,818.82
N.Tyne - T45a	842,839.87 person days	£244,642,330.10
Mile 48	47,946.39 person days	£13,898,207.50
45a - Irthing (ex 48)	155,616.40 person days	£45,047,817.40
Turf Wall	1,393,909.82 person days	£230,141,983.40
Sub Total	3,929,360.75 person days	£964,994,128.43
49-54 (Rebuild)	230,666.49 person days	£70,563,735.44
54-80 (Rebuild)	1,391,224.00 person days	£425,592,654.70
Total	5,551,251.24 person days	£1,461,150,518.57

Table. 6.18: Stone wall labour and cost.

§ 6.6.2 | Symbolic Meaning and the Curtain Wall

As with the forts, the connexion between the Wall's structures and Roman cities was an important link. The curtain takes this relationship and adds an element of over-monumentality which the forts do not possess. However, the presence of the curtain appears contradictory as it is superfluous for many of our interpretations of the Wall's function. For example, signalling is reliant on interval

[124] See §3.4.

structures, and not the line of the curtain[125] and Luttwak's model of a 'scientific frontier' is predicated on all threats being met beyond the province itself.[126] Similarly, the customs barrier theory can also be covered with judiciously placed installations and does not necessarily need the sealing of the Tyne-Solway isthmus.[127] By this definition, monumentality is achieved as the curtain's importance seems to outweigh its practical function.[128] As a consequence, it is possible to conjecture that the curtain, as with the rest of the Wall, is designed with intentional symbolism, just as Trajan's Danubian bridge and forum were designed as victory monuments to prolong the memory of the successful Dacian conflicts.[129]

Importantly, monumental structures, as can be seen by the many monumental public buildings around the Roman world, were intended to be used,[130] and it is through use that the power of the Wall can be seen. Due to the anatomy of the curtain, crossing can only be performed through the forts and milecastles, thus the repetition of these structures are absolutely vital in imbuing the curtain with both the opportunity of use and the symbolism of soldiery. The lack of evidence for a wall walk further emphasises the importance of the interval structures, without these the soldiers would have been far less visible. The curtain itself possesses much power as its very existence forces people to use the designated crossing points of the milecastles and forts. This also highlights the control over the body which the Romans maintained, conditioning the very movement of which people were capable. This serves to prevent the Wall from becoming empty rhetoric[131] and allows the

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[125] Woolliscroft, 2001.

[126] Luttwak, 1976, Chp.2; See §2.4 and specifically Fig.2.4.

[127] Kerr, 1989, *passim*; Hodgson, 2000, *passim* proposes a frontier with well-placed sites rather than a continuous cordon.

[128] Thomas, 2007, 5, 44.

[129] Even modern, seemingly clearly functional divisive structures have propagandistic elements. The Israeli 'peace wall', for example, shown in Fig.6.3, contains the message 'Peace Be With You', in three languages, from the Israel Ministry of Tourism. This represents a 'business as usual' message and a peaceful claim which seems at odds with this highly divisive structure.

[130] Thomas, 2007, 11.

[131] Contra Mann, 1990, 54.

Romans to attempt to control the meaning of the structure[132] and benefit from the effects of *praxis*.

The importance of the soldiers' physical presence cannot be stressed enough. Aelius Aristides' orations conflate military structures and the soldiery who built and manned them into one harmonious entity.[133] This unity was connected to the repetitious interval structures by propagating the concept of integration under Roman auspices. The soldiers, the literal 'building block' of this unity, are from all over the Roman world. Again, this aspect was exploited on Trajan's Column with clear representations of multi-ethnic soldiery.[134]

The curtain's connexion to display makes the materials used in construction an important aspect. In the eyes of the Romans the stone-built section would have been considered the greater achievement due to the use of stone and its comparatively large labour demand.[135] This would have demonstrated the manifest achievements of Roman technical ability and labour resources. Furthermore, there was a material connexion between the emperor and stone-built structures which, as will be seen, was symbolically vital.[136] Clearly, the structure of the curtain was intended to be admired for its scale and the effort required to achieve this, and not just the function.[137]

The curtain, however, projected more than an image of control over vast resources and labour. For example, the visibility of the foundation or offset courses[138] provided a subtle visual link to the literary tradition of the solidity of the Roman state being represented

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[132] Evans, 1988, 93: '[…] societies objectify themselves through their acts in nature.'
[133] Thomas, 2007, 46.
[134] See Fig.6.8; §3.4.1 and Fig.3.8.
[135] See §6.7.
[136] It is not just material connexions that link the emperor and structures. Specific architectural styles gain imperial associations and their replication becomes a way of expressing loyalty and affiliation. Thomas, 2007, 157.
[137] Thomas, 2007, 182.
[138] See §4.4, Fig.4.2.

as foundations upon which the Roman world rested. Thus this idea of a strong state and emperor can be seen in the structure of the Wall.[139] As this was the standard method of wall construction by the Roman military in this period, this message is contained within the interval structures as well as the curtain, however, it is the curtain which is the most visually prominent and expansive example.

This sheer scale creates a parallel between the artificial construct of the curtain and Nature. This magnitude showed the Wall as a landscape in its own right. There is a tradition in the Roman mind of comparing vast structures to the natural world, and the curtain's grandeur would evoke such comparisons.[140] The symbolism was at times brutal in its simplicity, as the curtain cuts a line across the landscape of the Tyne-Solway isthmus, cresting the Whin-Sill as easily as the Solway Firth, the dominance of the Romans' technical skill over nature is demonstrated. Nature herself can be made subject to Rome, and walls demonstrated this by giving shape and unity to previously formless terrain.[141] Pliny the Younger demonstrates this nature/structure relationship when likening the area around his Tuscan villa to 'an immense amphitheatre of the kind only Nature can construct.'[142] This is a clear display of power which would be highly evident to those who inhabited the now drastically different landscape. Once again this is commensurate with the overwhelming of pre-existing *genius loci* that the structure of the Wall as a whole appears to perform. This emphasis on power is clear, and is connected to the emperor through the Roman conflation of size, scale and difficulty of construction with

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[139] Thomas, 2007, 18. Construction could be used as a metaphor for 'ambition' and 'magnificence', similarly poor structures reflect badly on the patrons and people who built them. Thomas, 2007, 83-4. Interestingly, some structures had their foundation offset courses visible from the outside. Haltwhistle Burn is one such example, this would also place the technical skill of the soldiery on display. See Gibson & Simpson, 1909, 230, Fig. 14.

[140] Thomas, 2007, 20.

[141] Thomas, 2007, 108, 240.

[142] Plin. *Ep*. 5.6.7: Regionis forma pulcherrima. Imaginare amphitheatrum aliquod immensum, et quale sola rerum natura possit effingere. Lata et diffusa planities montibus cingitur, montes summa sui parte procera nemora et antiqua habent.

concomitant political power and the person of the *princeps*.[143] The curtain's scale and materials guarantee this connexion and the Wall was clearly meant to evoke both wonder and terror.[144]

The curtain, whilst a linear structure, has a structural vocabulary shared with the forts and based on city walls. As noted with the forts, this was intimately connected to civic identity and both images and sculptures of walls and gates could become a visual shorthand for the city itself. Importantly, this also connects to the idea of demarcation; moving through city walls connotes a movement from one state to another, rural and urban, for example.[145] In the case of Hadrian's Wall this need not be the movement from a state of non-Roman to Roman, or vice versa. This is too literal and modern an interpretation of a boundary.[146] The existence of Terminus, who could reside in the eastern curtain due to its stone-built nature, shows these are boundaries within Roman space and were divinely ordered.[147] Thus the curtain would not be involved in the denotation of the literal end of Roman power, this concept is itself *contra* the prevailing idea of *imperium sine fine*, but rather a movement between states dictated by the Roman ordering of space. Again, it is the structures and soldiers of the Wall which are, in effect, disseminating the terms for conditioning space.

This space is, importantly, part of an enclosed unity which the structures between the ditch and vallum provide. This provides a highly visible focus for the expression of Rome and its *maiestas* which inspired respect and terror as a means to its end. Importantly, like the city, this focus was not at the centre[148] but rather at the perimeter. Just as the city's identity could be represented by its walls and gates, so too could the many and manifest aspects of

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[143] Thomas, 2007, 150, 190.
[144] Mattern, 1999, 22, 149, 172-3; Thomas, 2007, 153, 208.
[145] Thomas, 2007, 111, 210.
[146] Rykwert, 1976, 136; Isaac, 1992, *passim*. See §2.2.1.
[147] Rykwert, 1976, 90-1. Hyginus Gromaticus claims 'boundaries are never drawn without reference to the order of the universe', Hyg. Grom. *De const. limit*.
[148] On an empire-level scale, this would have been the city of Rome.

Rome, becoming Roman and the Roman ordering of space, be represented away from the very seat of imperial power. This is vital to understanding how Rome extended its grasp over Europe and the Mediterranean world. This is further reinforced with the conflation of frontier works and people as a point of glory for Rome, as shown in Aelius Aristides' orations on the Roman frontiers:[149]

> Men who hold out their shields in protection of those walls, not believing in flight […] So closely do their helmets join to one another that an arrow could not pass between. Their shields raised over their heads would hold elevated walks so much more stabile than those fashioned in the city that it is possible for even the cavalry to ride upon them […] And their breastplates so closely cling to one another that even if you should station an unarmed man in the middle, he is protected by the armaments at each side. And their spears falling like rain form a steady stream. In such harmony then have been enclosed the circle of their tactical revolutions and the circle on the borders of the whole world.

City walls and roads both share a direct relationship as examples of the emperor's largesse.[150] Whist the adoption of city walls as the connecting feature of the installations of the Wall provides the above symbolic messages, it is not the case that roads are without semiotic impact.[151] Consequently a decision must have been made to prefer connexion via the curtain than through roads. The curtain provided Hadrian with a subtle propaganda link which would not be present with the use of roads. As noted, through the curtain and forts the presence of the Roman city is associated with the Wall, through patronage, imperial cult worship and the reification of the emperor with his works, Hadrian himself is immanent on the Wall.

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[149] Aristid. *Or*. 26.84. Behr, 1981, 91; Thomas, 2007, 46.

[150] Emperors would regularly grant tax breaks to stimulate the construction of roads to connect settlements, and walls to promote civic identity in a Roman framework.

[151] See Witcher, 1998.

Cities themselves require heroic founders[152] thus Hadrian puts himself in the position of the heroic founder of the 'city' of his Wall.[153] This link is perhaps more important than a simple propaganda message of power, Hadrian's broader programme includes the institution of the Panhellenium in A.D. 131/2. The key requirement for a city's entry into this institution was a founder present in the Homeric epics.[154] Hadrian, as a 'city' founder with the Wall,[155] gently aligns himself with this practice and the heroes of Homer's age. This in turn connotes both Rome's Homeric founder Aeneas and Augustus, who claims descent from the eponymous hero of Virgil's poem written under his patronage. This is a subtle and powerful link to legitimacy for those with enough cultural knowledge to allow comprehension. The Panhellenium was instituted after the completion of the Wall, the existence of which thus granted Hadrian entry within his own institution. In this sense Hadrian's Wall is a very real attempt at establishing Rome and specifically Hadrian's right to set the cultural agenda across the Roman world.[156] Indeed, in this sense the Panhellenium was very much Hadrian having the power to play a game to which he had set the rules,[157] it is testament to his power and actions that others chose inclusion. Hadrian's Wall is the manifestation of this process in Britannia.

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[152] Rykwert, 1976, 35.

[153] The link between walls and the reification of cities is important here. As is the fact that wall building and city foundation can be effectively interchangeable. Rykwert, 1976, 156. Further weight is added by Hadrian's Greek titles, which were based around city foundation, Boatwright, 2000, 30-1.

[154] Boatwright, 2000, 149-50.

[155] Whittaker, 1997, 144.

[156] Whittaker, 1997, 148: '[easing tensions] was achieved through the adoption and adaptation, by Augustus himself in Rome, of Hellenistic euergetism and alimentary schemes. Absorbed into the competitive ethos of the city, such expenditure was not so much for the greater glory of local élites, that is, in defining their superiority within the social system, as to institutionalize the relations of poor and rich and lock them both into the same value system.'

[157] Boatwright, 2000, 13.

§ 6.7 | The Earthworks

The earthworks of the Wall are present to both the north and south of its line. The ditch, situated north of the Wall, is a relatively standardised feature of Roman military construction taking the form of a v-shaped ditch with a small sump, and a mound formed by the up-cast to the north called the *glacis*.[158] Figure 6.11 shows the basic shape and range of dimensions for the ditch's anatomy:

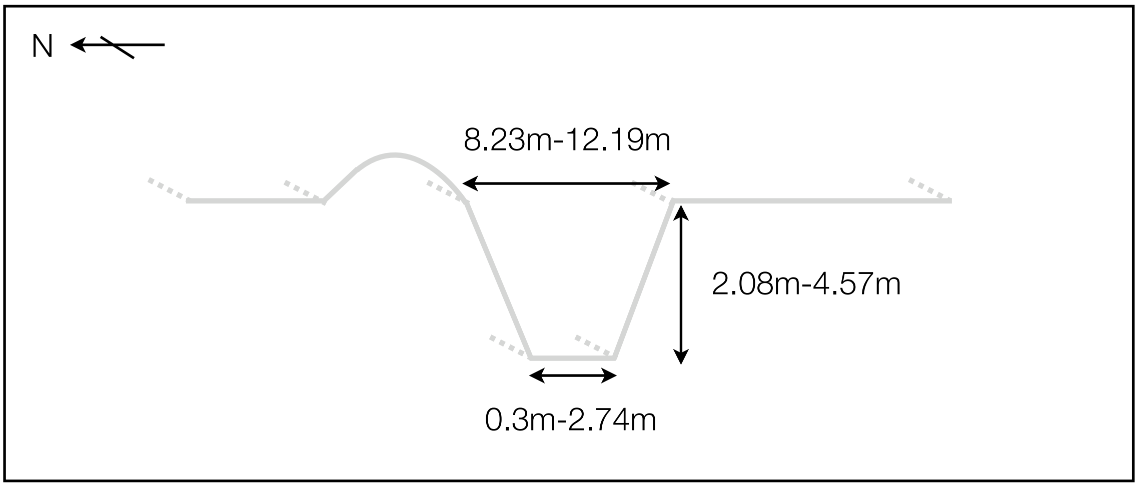

Fig. 6.11: The ditch and its variable dimensions.

In comparison the vallum is an earthwork of far greater complexity and mystery. Firstly, its 'ditch' is atypical in its size, variability and shape. Furthermore, this sits between two large mounds to the north and south. The vallum's anatomy is shown on Figure 6.12:

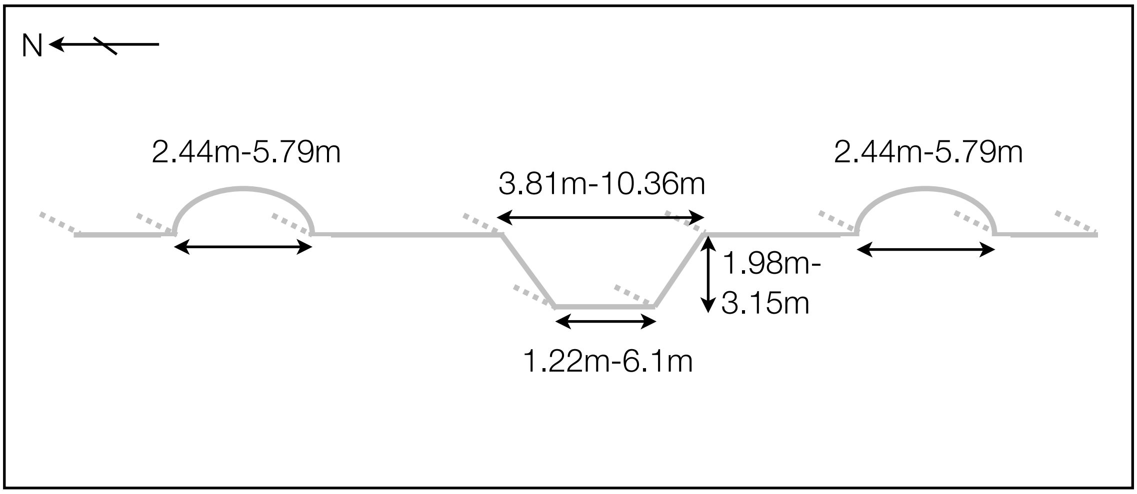

Fig. 6.12: Vallum anatomy and variability in dimensions.

[158] Breeze, 2006b, 62-3.

There is further complexity to the vallum in that the north and south mounds are revetted, either in turf or stone kerbing. This adds a large labour and material demand to the otherwise relatively straightforward, and ditch-like, structure of the vallum.

§ 6.7.1 | Earthworks' Quantitative Survey

The fact that both vallum and ditch are broadly turf-built means that there is the ever present problem of survival familiar from the turf wall. Consequently, in order to project the dimensions of the ditches and vallum, the measurements of the area where they were discovered are presumed to run along the line of the Wall until new evidence is found. Where there is no evidence, an average of the figures is used to proxy the ditch or vallum. For example, the dimensions of the ditch to the east of Heddon-on-the-Wall are presumed to run to MC23, where other evidence takes precedence, and runs to Halton Chesters. Since the vallum occurred right across the length of the Wall, except in the Wallsend-Newcastle area,[159] averages are used to extend its coverage beyond the surviving evidence from Newcastle to Bowness. The ditch runs for much of the Wall's length, though not over crags, the Solway marshes and the bluff above the River Eden to the west of Carlisle.[160] First, the Wall ditch: the different zones and results of the quantitative survey can be seen on Table 6.19.[161]

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[159] Breeze, 2006b, 84.

[160] Breeze, 2006b, 62.

[161] Ditch survey can be found in §A2.8-10. As the *glacis* is formed from upcast merely heaped to the north of the ditch, labour estimates for this process are not made. In areas by MC30 and MC50 SW the *glacis* may merely be debris from later ditch cleaning, by T43ab, MC22 and T51b there is no evidence for smoothing of the upcast. The low labour demand of turf work, as §4.6 shows, and the small percentage of cost and effort the ditch represents, as seen in Figs 6.14-5, mean that any extra cost associated with the *glacis* would be negligible.

Table 6.19			
Ditch Zone	Work Rate	Total Cost	Labour Cost
Newcastle to Benwell	9,598.83 person days	£4,338,670.26	£1,267,045.30
Benwell to Rudchester	11,898.50 person days	£5,378,120.64	£1,570,601.60
East of Heddon on the Wall	25,904.20 person days	£11,708,698.29	£3,419,354.37
Stanley (MC23)	11,032.01 person days	£4,986,468.80	£1,456,225.40
Halton Chesters East Gate	3,102.63 person days	£1,402,387.74	£409,546.86
Chesters	14,008.71 person days	£6,331,937.99	£1,849,150.03
Cockmount Hill	3,860.36 person days	£1,744,880.84	£509,566.97
Carvoran to Thirlwall	2,499.95 person days	£1,129,978.11	£329,993.61
Thirlwall to Birdoswald	12,561.12 person days	£5,677,626.24	£1,658,067.84
Birdoswald	10,196.12 person days	£4,608,647.26	£1,345,888.14
Average Used	42,687.79 person days	£19,294,881.79	£5,634,788.49
Total	147,350.22 person days	£66,602,297.96	£19,450,228.61

Table 6.19: Results of quantitative survey of Wall ditch in labour and cost.

In line with the project methodology the total cost includes the fiscal outlay on turf. In the case of turf ramparts and structures like Drumburgh, this represents the materials used to build the installations themselves. Such costings are not appropriate for the ditch as the earth is not used in construction. Consequently the 'cost' column of Table 6.19 includes the turf and is presented in order to maintain convention. However, a new column shows the outlay of the project solely on labour, excluding the materials cost. As can be seen, the cost of the turf is by far and away the most expensive element, more than trebling the cost when included. The overall labour requirement of *c*.150,000 person days means that a build team of some 750 persons, or one *milliary* unit, could complete the ditch system in one 200 day building season.[162]

Secondly, the results of the quantitative survey for the vallum ditch and mounds can be seen on Table 6.20.[163]

[162] Exact figure: 736.75 people.

[163] Quantitative survey can be found in §A2.11-5.

Table 6.20		
Vallum Ditch Zone	Work Rate	Cost
Newcastle - Benwell	4,480.59 person days	£2,070,034.23
Benwell - Rudchester	15,526.78 person days	£7,173,372.59
Rudchester - Halton Chesters	15,930.50 person days	£7,359,890.08
Halton Chesters - Chesters	11,625.58 person days	£5,371,017.93
Chesters - Carrawburgh	6,544.79 person days	£3,023,694.64
Carrawburgh - Housesteads	10,394.97 person days	£4,802,477.01
Housesteads - Great Chesters	7,875.92 person days	£3,638,674.58
Great Chesters - Carvoran	9,189.89 person days	£4,245,728.26
Carvoran - Birdoswald	2,799.33 person days	£1,293,289.51
Birdoswald	1,407.34 person days	£650,191.66
Birdoswald - Castlesteads	7,163.95 person days	£3,309,746.04
Castlesteads	517.84 person days	£239,244.04
Castlesteads - Stanwix	24,088.24 person days	£11,128,766.52
Stanwix	866.82 person days	£400,468.85
Drumburgh - Bowness	13,774.61 person days	£6,363,872.12
Ditch Total	132,187.16 person days	£61,070,468.06
Vallum Mound Zone	Work Rate	Cost
Benwell - Rudchester	10,9414.78 person days	£15,536,899.24
Housesteads - Great Chesters	38,682.16 person days	£5,492,866.31
Birdoswald - Castlesteads	73,947.03 person days	£10,500,478.50
Where Average Used	64,6372.48 person days	£91,784,892.32
Mound Total	868,416.45 person days	£123,315,136.37
Overall Total	1,000,603.61 person days	£184,385,604.43

Table 6.20: Labour and cost of vallum ditch and mounds.

The difference in labour demand, and thus overall cost, between the ditch and the vallum is quite pronounced. Part of this is undoubtedly due to the complexity of the vallum when compared with the ditch. The overwhelming majority of this cost can be attributed to the complex construction of the mounds, as can be seen, these account for nearly 90% of the total labour demand.

Similarly, including materials, this complexity can be seen in that the vallum was almost three times more costly than the ditch. Furthermore, the vast expenditure of labour and cost on the mounds when compared to the vallum's flat bottomed ditch highlighted their importance as a key part of the vallum's structure. This vast labour demand makes the vallum the third most costly structure on the Wall to complete, which is all the more significant as it is a predominantly turf-built structure.[164]

Closer inspection of the vallum's survey results reveals a very significant phenomena. Table 6.21 shows the volume of earth excavated in the creation of the vallum ditch compared with the volume present in the mounds:

Table 6.21	
Feature	Volume of Turf
Vallum Ditch	1,057,497.28m^3
Vallum Mounds	970,563.22m^3

Table 6.21: Volume of turf in Vallum ditch compared to Vallum mounds.

The difference between these two volumes is a mere 8.96%. This indicates the up-cast from the vallum ditch was most likely reused in the mounds. The closeness in results for each of these features is in contrast to the findings of experimental archaeology. The reconstruction at the Lunt found that the up-cast from the ditch only filled one sixth of the core of the rampart.[165] However, it must be noted that these results are for mounds that were significantly smaller in the amount of turf they required than a full sized four metre tall rampart.

Both the vallum and the ditch are large expansive structures covering almost the entire length of the Wall. Indeed, the vallum itself is so large that it equates to one fifth the total labour of the curtain, and, excluding the forts, is unmatched in its requirements by

[164] See §6.8.
[165] Hobley, 1967, 87.

the interval structures. The labour requirement to complete the two structures in one building season is shown on Table 6.22:

Table 6.22		
Feature	Work Rate	Build Team for One Season
Ditch	147,350.22 person days	736.75
Vallum	1,000,603.61 person days	5,003.02

Table 6.22: Persons required to complete ditch and Vallum in one season.

This information reinforces the idea that the works could have been constructed in one building season by whole units. For example, the vallum equates to less than one legion involved in construction, the ditch to one *milliary* unit. Interestingly, the combined labour demand of the two earthworks still broadly equates to one legion. This may indicate that both the Wall ditch and Vallum complex were conceptualised and planned together, meaning that the Wall's earthworks were designed to be theoretically completed in one season. However, the very large labour demand indicates there was every chance that the vallum would have taken more than one building season to complete as the problems and situations 'on the ground' took their toll. This is in line with the chronology of the Wall's development, which shows the vallum being constructed after the fort decision, which did not occur until the third season. The evidence for this comes from forts, such as Benwell, whereby the vallum, which often runs very close to the Wall, takes a detour to skirt the site.[166]

§ 6.7.2 | Symbolism and the Earthworks

The earthworks are key features in Hadrian's Wall. However, the materials from which they are constructed means that they do not survive as well as the stone-built sections of the Wall. Nevertheless, as seen with the symbolism of the forts, earthworks are an intrinsic part of Roman settlements and their presence should not be

[166] Breeze & Dobson, 2000, 57-8; Breeze, 2006b, 86, 152, 154. See Benwell on Fig. 6.2.

surprising.[167] Indeed, the appearence of earthworks is indicative of the link between Hadrian's Wall and the structural vocabulary of the Roman city. The earthworks of the Wall are, however, radically different: the ditch to the north of the Wall is a feature found throughout the Roman world; the vallum, to the south, is unique to this monument.

Meaning and symbolism of the ditch has much in common with fort earthworks, though the Wall's ditch reflects the curtain's monumentality. Again, its ability to demarcate and connote sacred territory without removing focus from the curtain is a key aspect. As with the curtain, the ditch stresses scale, it disappears beyond the horizon and the ability of a viewer to see all. Thus the projection of power and control of body becomes a facet of the ditch's symbolic meaning in much the same way as the curtain itself. However, whilst the curtain seeks to overwhelm the landscape and the *genius loci*, the ditch portrays a meaning at once both subtle and violent. The profundity of scarring the landscape to form the ditch sends a clear message about the might of Rome;[168] subtly, however, it represents the organic whole of the Wall through enclosure. That this unity is punctuated regularly by opportunities for crossing is the first statement of the 'terms' of Roman peace, discussed supra.[169] These terms included crossing, and thus sublimating oneself to the Roman order, as a requirement which in turn provided the opportunity for becoming part of that harmony.

The Wall's structures all house soldiery in one form or another, even the curtain is connected to this facet through the close integration of interval structures. This aspect is denied for the Wall's ditch, instead the power of direct association with the soldiery was maintained

[167] Rykwert, 1976, 134.

[168] Quarrying also shares this feature, and further emphasises Rome's dominance over nature.

[169] See §6.4.2.

through maintenance.[170] The Cumbrian coastal ditches, along the Cardurnock peninsula,[171] show multiple recuts. Whilst this was doubtless due in part to the inhospitable terrain on England's north-west coast, some maintenance would have been required on the Wall's ditches. The continuous and repeated nature of such work would have displayed the technical skill of Rome's soldiery for turf and timber structures. Much propaganda imagery stresses these aspects[172] and the Wall itself was testament to these skills on stonework. These repeated acts made Roman technical skills visible on a regular basis.

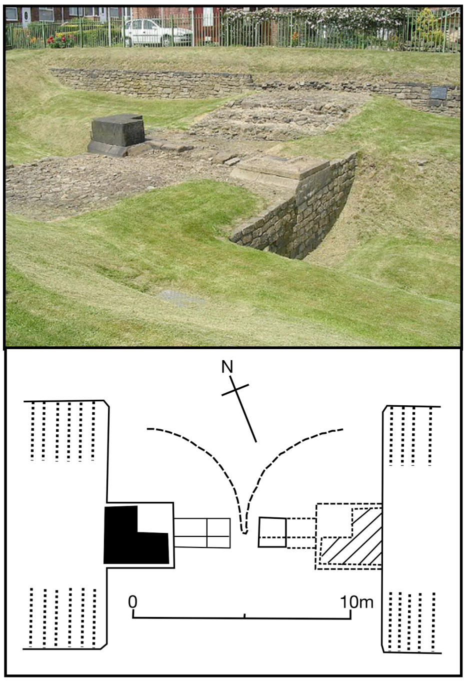

Fig. 6.13: Benwell Vallum crossing.

The vallum is an altogether more complex structure which requires a nuanced interpretation. As noted, the vallum is located south of the Wall and thus has similar implications in terms of stressing a unity of space as the ditch. However, the vallum's mounds are a far more imposing structure and thus create a secondary point of focus away from the Wall-complex, an element which the ditch to the north avoids. Places of crossing are just as important to the vallum as the ditch, however, this is a far more invasive solution than the ditches. As Figure 6.13 shows, the Vallum crossings possessed large gateways. These are based on the surviving masonry, which is the best dressed of any stonework, resulting in a gateway larger than that of a typical fort entrance.[173] This naturally imbued the crossings with many of the characteristics of moving through the milecastles

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[170] Pliny *Ep*. 10.70.2 records the unfinished and unmaintained structures were an eyesore, this was connected to the vice of over-building, *aedificatio*, and a state of disrepair for the Wall would have reflected negatively on its patron. Boatwright, 2000, 106; Thomas, 2007, 21.

[171] See §7.2.

[172] Trajan's Column for example, Rossi, 1971, 99, 101. See §3.4 and Fig.3.6.

[173] Breeze, 2006b, 154-4; For excavation of Benwell Vallum crossing see Birley *et al*., 1934, 176-84.

and forts. Importantly, the addition of an extra vaulted archway once again restates the case for subservience to the Roman ordering of space, this was accentuated by its large size and the amount of effort expended on dressing the stonework. The secondary focus which the mounds provided demonstrated Roman mastery of turf built structures.

As noted, the vallum was far more labour intensive than the ditch. Thus its symbolism went beyond that of being a ditch with a milecastle gate. The vallum's high cost and complicated structure represented power over large labour resources and the technical ability of Rome. Its material demonstrated mastery of all forms of building. Much of the Wall's demonstration of labour and technical skill was connected to stone. There were, consequently, few indicators of meaning for turf-built structures in the final form of the Wall. The vallum's revetted mounds and deep trapezoidal ditch provide this feature right across the length of the Wall. Thus traversing the structure always exposed the same message and covered all types of 'material rhetoric'.

As always, subtle displays are utilised, the vallum created a secondary focus that was still overshadowed by the Wall-complex. Given the associations of the Wall with the Roman ordering of space and the emperor Hadrian himself, the placing of the turf-built vallum as secondary to the Wall provides a powerful image of the power of Rome, her pantheon and of the emperor over the landscape. Similarly, the provision of gateways allowed sublimation to Roman order to take place in a context of turf-built structures. In this way the vallum is more than just a mere demarcatory structure,[174] but had an active role in the dialogue taking place in and around Hadrian's Wall.

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[174] Breeze, 2006b, 86 describes the vallum as 'defining the limit of the military zone'. Dobson, 1986,

§ 6.8 | The Wall as a Whole

The individual anatomical quantitative surveys can be combined to give an idea of the total labour and cost requirement for the Wall. As ever with the quantitative process this requires some level of conjecture. As noted, the Wall's structure is not entirely complete. Consequently, averages of the structures which survive in enough detail to be quantified are used as proxies for the missing structures.

Table 6.23 shows the results of this process, representing the total labour demand and cost for all sections of the Wall, as completed with turf west of the Irthing and stone in the east:

Table 6.23				
Feature	Total	Known	Work Rate	Cost
Turrets	161	27 (east); 9 (west)	85,262.89 person days	£24,470,059.55
Milecastles	79	19 (stone); 2 (turf)	443,987.33 person days	£95,630,861.33
Forts	14	7 (stone); 1 (Turf)	996,608.39 person days	£279,640,476.93
Curtain	--	--	3,929,360.74 person days	£964,994,128.50
Ditch	--	--	147,350.22 person days	£66,602,297.96
Vallum	--	--	1,000,603.61 person days	£184,305,684.40
Total			6,806,034.02 person days	£1,615,643,508.67

Table 6.23: Labour and cost per structure type on the Wall.

In terms of labour, the curtain has the greatest demand, followed by the forts, then the vallum. This highlights the importance of the linear features of Hadrian's Wall. Figure 6.14 shows a breakdown by labour whilst Figure 6.15 shows a similar breakdown by cost:

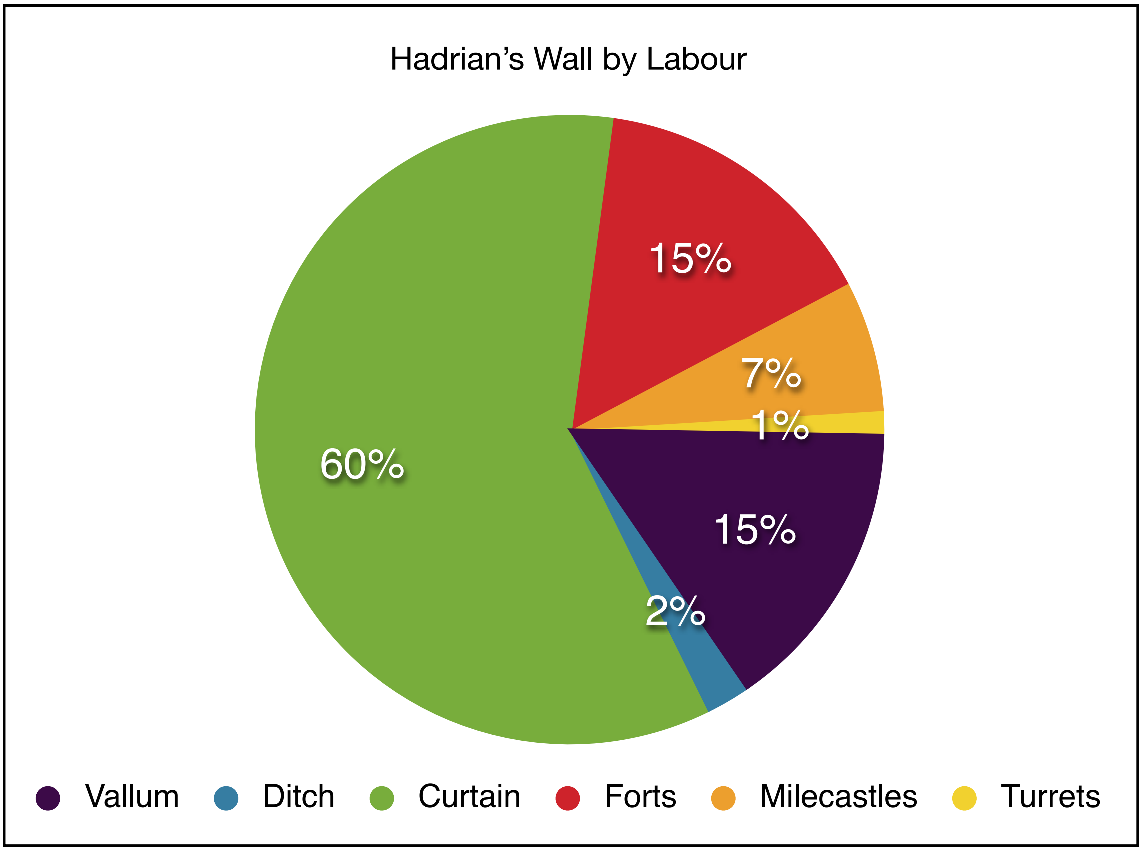

Fig. 6.14: Wall anatomy by labour.

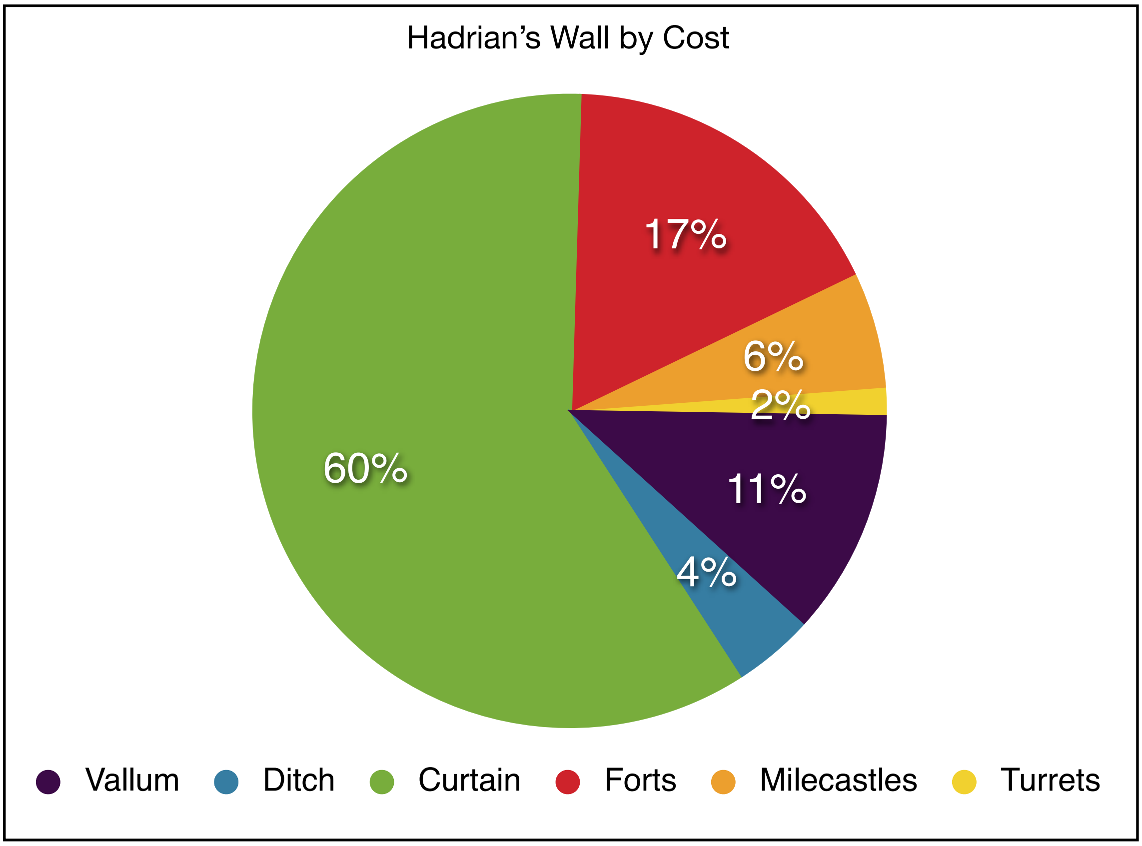

Fig. 6.15: Wall anatomy by cost.

The minor differences in the relation of cost to labour demand are highlighted here, with stone-built structures like turrets gaining in relative prominence. This is due to the comparatively high cost of stone in comparison to turf and timber.

Whilst going slightly beyond the remit of the study, the data collected for the quantitative survey does include the later fort addition of Carrawburgh as well as the stone rebuild of the turf wall west of the Irthing. This is relevant as it raises some fundamental questions about the Wall. The turf area begins at wall-mile 49 and runs to the curtain's termination. Its reconstruction in stone commenced in the period between A.D. 128-138, the area from wall-mile 49-54 was constructed, with the remainder reconstructed after the return from the Antonine Wall.[175] By overlying the turf wall, the rebuild has done much to limit archaeological knowledge of the Wall's turf and timber structures. Fortunately, in areas such as wall-mile 49-51 the stone wall deviates from the line of the turf original, allowing some of the turf's anatomy to survive. The labour and cost requirements for the rebuild can be seen on Table 6.24:

Table 6.24		
Structure	Work Rate	Cost
Milecastles	219,978.03 person days	£52,823,493.38
Forts	743,399.89 person days	£204,753,553.87
Curtain	1,621,890.49 person days	£494,957,174.80
Total	2,474,704.72 person days	£752,534,222.05

Table 6.24: Labour and cost per structure for Wall rebuild.

The total requirement of the rebuild of *c*.2.5 million person days equates to approximately one-third of the required labour needed to build the original Wall. This is clearly a substantial sum and is emphasised by the cost of nearly 50% of the original project. This is all the more evident given that the stone rebuild, in occupying 31 wall-miles, accounts for 38.75% of the total length of

[175] Breeze, 2006b, 58-62.

the Wall. Thus the new areas see a far greater commitment in resources and labour than their counterparts east of the Irthing. This certainly intimates that constructing in stone was very important for the Wall, and the high levels of labour required underline this fact. Similarly, such high levels of labour and stone used in the reconstruction demonstrates that supply to this area was not a problem. This serves to invalidate the claim that turf construction was carried out originally due to the difficulty in using stone in the area west of the Irthing.[176] Figure 6.16 shows the breakdown of the stone rebuild in terms of labour:

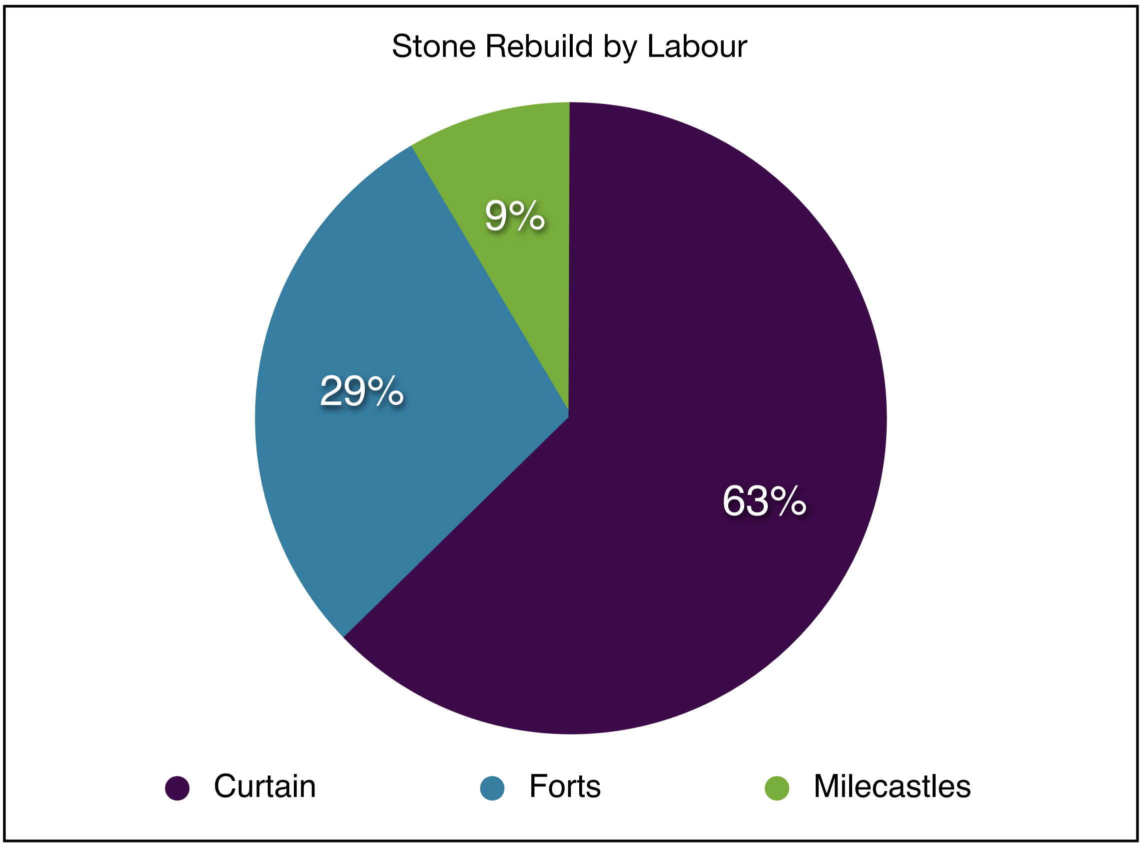

Fig. 6.16: Stone rebuild by labour.

The rebuild is similar to the original Wall, notably, the heavy importance played by the curtain is maintained. In this instance, the work expended on the forts far exceeds that of the milecastles. This relationship is maintained when the fiscal cost of the Wall rebuilding programme is considered on Figure 6.17:

[176] For discussion on this, see Breeze & Dobson, 2000, 32.

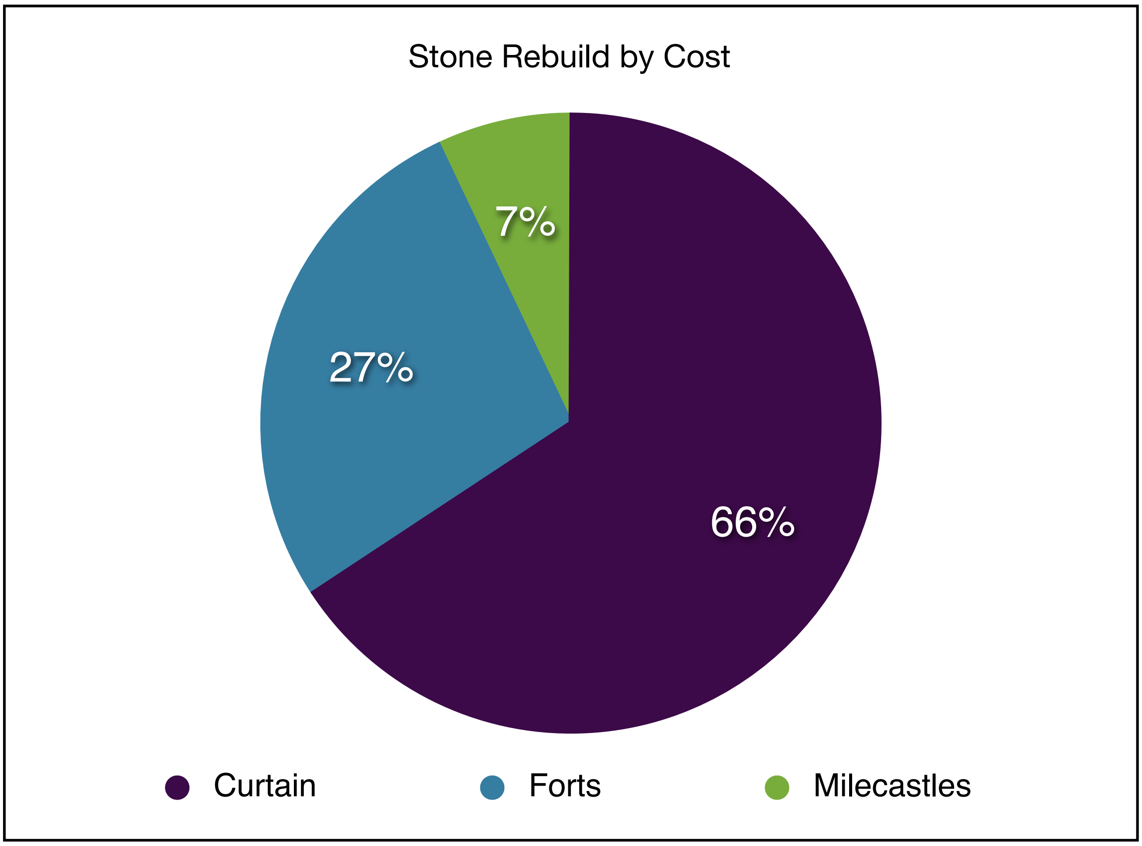

Fig. 6.17: Stone rebuild by cost.

§ 6.8.1 | The Division of Labour

With the full results of the quantitative survey compiled, it is possible to consider the Wall in terms of the labour requirement per building season to achieve completion within the Wall's chronology. This chronology is shown on Table 4.11, but repeated here as Table 6.25 for convenience:

Table 6.25					
Year	Stone Wall	Turf Wall	Cumbrian Coast	Forts	Vallum
122	MC4-MC7				
123	MC7-MC22	MC49-T64b(?)	T80b-MF20(?)	Outpost forts planned (commenced?)	
124	MC22-T27a T36b-Irthing	MC65-T80a(?)	MF20-MF40(?)		
Dislocation by Fort Decision					
	Remaining Structures T27b-Irthing	Continuing (?)	Continuing (?)	Primary forts commenced	Commenced
125	Continuing			Continuing	Continuing
126	Reduction in gauge of curtain (?) continuing work on MC22-Irthing			Continuing	Continuing
Governorship of Platorius Nepos Ended (?)					
127	Continuing/ extension to Wallsend			Continuing	Continuing (?)
128-38	Completion of curtain/extension to Wallsend	Rebuilding in stone commenced		Completion of primary forts, Carrawburgh added, Cumbrian forts completed, Outpost forts completed (by *c*.130?)	
136-7				Carvoran rebuilt in stone	

Table 6.25: Hadrian's Wall chronology.

Table 6.26 shows the number of person days required per year of the construction process according to the chronology of works:[177]

Table 6.26			
Year	Work Rate	Soldiers	Difference
A.D. 122	198,051.64 person days	990.26	n/a
A.D. 123	1,938,187.24 person days	9,690.94	8,700.68
A.D. 124	1,753,159.82 person days	8,765.80	-925.14
A.D. 125	853,379.10 person days	4,266.90	-4,498.90
A.D. 126	853,379.10 person days	4,266.90	0.00
A.D. 127	951,505.17 person days	4,757.53	490.63
A.D. 128	664,516.71 person days	3,322.58	-1,434.95
A.D. 129	262,989.61 person days	1,314.95	-2,007.63
A.D. 130	262,989.61 person days	1,314.95	0.00
Total	7,738,157.99 person days	38,690.81	n/a

Table 6.26: Number of soldiers required per year.

Importantly the total number of soldiers shown here is an absolute theoretical maximum, presuming soldiers completing their work and not moving on to work elsewhere on the Wall. The 'on the ground' reality of the total soldiers will have been far below the level set here. This total demand can be plotted against the number of soldiers needed to fulfill the work requirement per building season by the Wall's known chronology. This is shown on Figure 6.18:

[177] The data are presented fully in Appendix 5. N.B: the data presented here includes quantitative data for the Cumberland coast and the Outpost forts.

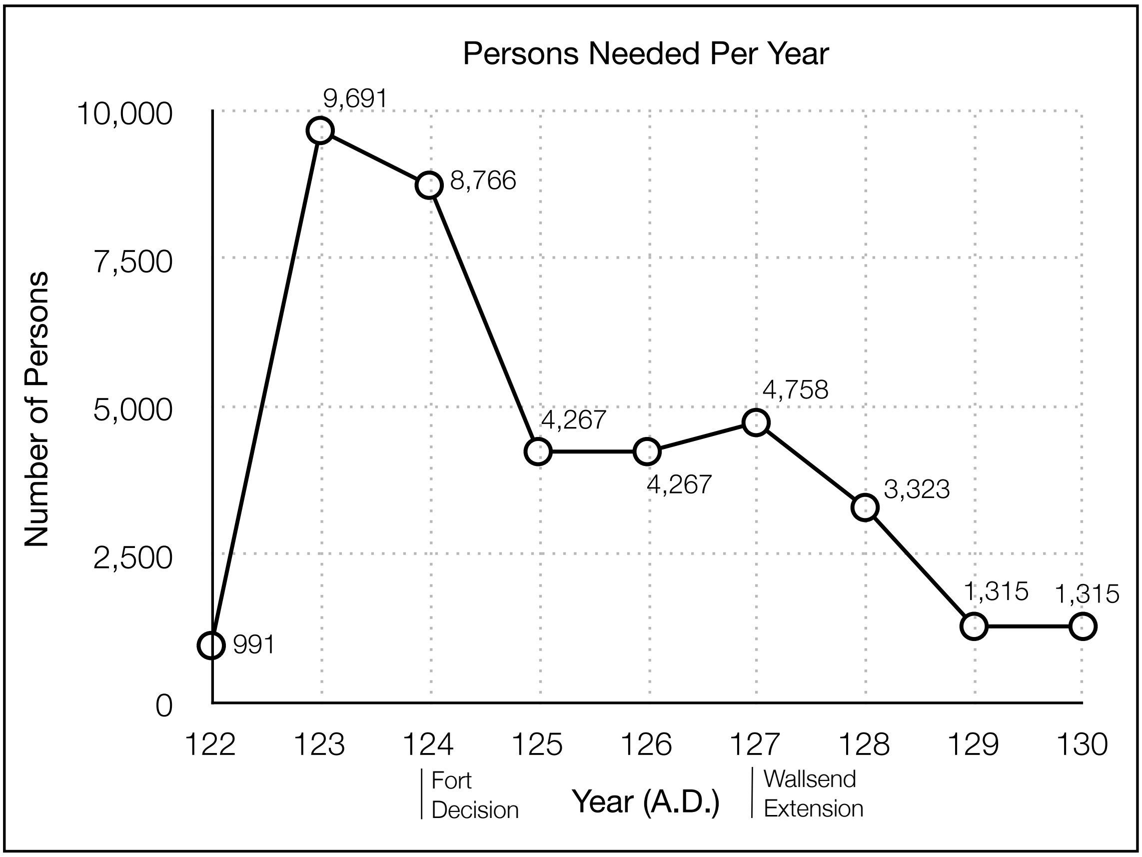

Fig. 6.18: Number of soldiers required per season.

As can be seen, the chart follows a distribution which starts low, increases rapidly, and gradually reduces over the course of the following years. The only discernible alteration to this trend being in A.D. 127, with the 11% increase in required workforce due to the Segedunum extension. The very low work force of the first build-season implies either low unit availability at the start of the project, or a late season start to the work. As noted, the sum of each season's required work force is the maximum number of soldiers required over the whole construction period. This sum of 37,877 is in excess of the presumed number of auxiliaries that would garrison the Wall (*c*.10,000),[178] and the available citizen soldiery of the three legions (*c*.18,000).

This would have been the least efficient use of the work force, these figures imply that a greater level of efficiency was required. Consequently, at its most efficient, the Wall never needs more soldiers assigned to its construction than the peak fluctuation, in this

[178] Breeze & Dobson, 2000, 54.

case the *c*.9,500 men needed in A.D. 123, neatly dovetailing with the total paper strength of the units on the Wall.[179] It must be noted that this quantitative survey is restricted to on-site activities, whilst this includes factors like haulage around the work site, it does not include aspects like haulage to the work site. Therefore, many of the soldiers would have to have been employed in some supply capacity. Consequently, legionary involvement in the Wall's construction can be seen, as attested by their inscriptions; freeing up labour to be used in broader supply. This would have had a broader symbolic power, given the propagandistic uses of citizen soldiery on Trajan's Column, for example. The question of supply specific to food, and the labour required to supply a *c*.10,000 strong body of soldiers is considered later in Chapter 9.

§ 6.8.2 | The Fort Decision

One of the main benefits of the quantitative methodology is that the data generated can be used to construct theoretical models. This is especially useful given the alterations caused to the Wall by the inclusion of the forts. How does the post-fort decision Wall compare to the original plan without integrated forts? This data can then be used to cast light on the reason for the fort decision and the change in curtain width which is often answered by functional theories, such as a need to speed completion.[180]

The results for the original design of Wall compared to the fort-decision Wall are shown on Table 6.27. This was calculated by taking the Dere Street area, the most likely starting-point for the Wall,[181] and applying the dimensions of the Wall in this area to the whole of the curtain. The quantitative results for the forts are not counted; the ditch and vallum are excluded as their form would have been broadly identical regardless of whether forts were integrated on the line of the Wall. Similarly, the turrets and the milecastles do not

[179] Breeze & Dobson, 2000, 54.
[180] Breeze, 2006b, 103-4.
[181] Breeze and Hill, 2002, 1-2.

need to be recalculated for the original plan as these would have been identical regardless of plan. The towers and milecastles which were replaced by the forts had already been built, thus no alteration of their figures is required.

Table 6.27			
Group	Feature	Work Rate	Cost
Original' Wall	Curtain	2,938,220.60 person days	£850,555,792.40
	Forts	n/a	n/a
	Total	2,938,220.60 person days	£850,555,792.40
Fort-decision Wall	Curtain	2,535,450.92 person days	£734,852,145.10
	Forts	996,608.39 person days	£279,640,476.93
	Total	3,532,059.31 person days	£1,014,492,622.03

Table 6.27: Comparison of fort-decision Wall with theoretical original Wall in labour and cost.

As can be seen from this table, the difference between the two projections is quite large, some 20%.[182] As a consequence it is not the case that the fort decision sped up the construction of Hadrian's Wall,[183] or that the saving made by moving to a thinner gauge of the curtain would completely offset the cost.[184] In short, the decision to move the forts to the line of the Wall extended either the required labour or the time needed to complete the project.

However, there is an interesting aspect to the fort-decision and the reduced curtain width. As noted, fort walls relate directly to civic identity that was represented by city walls. During the foundation of a city, ideally walls were built first before the division of the land or the construction of the public buildings.[185] In following this formula for fort walls, due to the relationship between forts and cities, the

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[182] Exact different: 20.8%.

[183] Breeze, 2000, 32 has noted this would not be the case for operational reasons, Roman military practice would see the army in the field, not by a defensive structure.

[184] Breeze, 2006b, 51.

[185] Rykwert, 1976, 54. This can be seen in Vit. *De Arch*, I.V.1.

quantitative survey produces interesting results with the internal structure omitted, shown on Table 6.28:

Table 6.28			
Group	Feature	Work Rate	Cost
Original Wall	Curtain	2,938,220.60 person days	£850,555,792.40
	Forts	n/a	n/a
	Total	2,938,220.60 person days	£850,555,792.40
Fort-decision Wall (Fort walls only)	Curtain	2,535,450.92 person days	£734,852,145.10
	Forts	273,220.55 person days	£63,450,252.05
	Total	2,808,671.47 person days	£798,302,397.15

Table 6.28: Fort-decision Wall, ramparts only, compared with 'original' Wall in labour and cost.

Evidently, this brings the totals for both labour demand and cost almost in-line with one another. The difference in required labour is a meagre 4.41%, the difference in cost is 6.14%, these would have been indistinguishable in reality. These results reinforce the importance of construction with a semiotic purpose in mind as they show that the outward appearence of the Wall could be constituted with no alteration in completion time. In short, the Wall would, from external appearances, seem complete at the same time with forts as without.

§ 6.9 | Conclusion: Symbolism of the Totality

This analysis of the Wall has stressed a number of key facets. First and foremost is that the quantitative analysis gives a direct way of analysing the effort required to build the structure. Whilst this seems functional, it is of extreme importance to the symbolic message of the Wall as there is an explicit connexion between effort and expense and the *maiestas* of Rome. Furthermore, it stresses the idea of the Wall as a unified whole, with each constituent part contributing to the symbolic power, not just the function, of the structure. It is this symbolic whole, which is deeply resonant with both the emperor and the wider Roman world, that is made available to all in the shape of Hadrian's Wall. Indeed, this is one of the key elements of the structure's strengths, its message was in part intended to be communicable through action, and thus did not require Latin literacy.

This unified whole can be seen in the close integration of the interval structures. This feature was unparalleled in other frontier works. The Danubian *limes*, for examples, sets both towers and forts back from the line of its palisade. This did not represent a different *modus operandi* between the Wall and the Danubian *limes*[186] as this would have been undesired due to the interoperability of Roman soldiery. Rather, it demonstrates that the symbolic meanings of the two structures were either different, or presented in a divergent manner. Whilst this point is highly conjectural, it may well be predicated on reception, the frontiers themselves being rendered in such a way as to make comprehension of the symbolic message easier by the 'natives' within the landscape. The change in the Wall's design over the course of its construction may have been to better achieve its goals in the landscape, part of which relied on the 'native' response.

The Wall's structures were not just integrated closely, but also repetitively. Consequently, the same symbolic message is available, regardless of where the Wall was encountered. Furthermore, this over-supply of interval structures, for example MC35 which cannot be used for crossing, presents an image of Rome being able to command almost limitless power, the over-supply and scale of control gives greater presence in the landscape and alludes to even greater numbers of soldiery.[187]

The journey across the Wall presented the symbolic message; importantly, it is an active, as well as passive, interaction. Firstly, the Wall can be seen from some distance which promoted Rome's position of power and dominance over the landscape. The Wall's

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[186] Dobson, 1986, 22-3 discusses the difficulties associated with various plans for operations from both the Wall, taken from Richmond, 1947, 21, and the German frontier, from Baatz, 1974, 45. Both plans are similar and both suffer from the same problems.

[187] Bowman, 2003, 18.

monumentalism would have been quite evident at this point, as it stretched beyond the ability of a single person to see the whole, overwhelming the eye and thus emphasising the imperial power. The materials of construction further stressed this: the stone alluded to the great power and effort required for construction and supply as well as the divine ordering in the presence of Terminus; the turf-built structures showed the natural world subverted and used to support Roman displays of power.

Those approaching the Wall from the north or south first encountered earthworks, either the Wall ditch or the Vallum complex. This stressed the enclosed space as part of a unified whole whilst simultaneously maintaining focus on the main structures of the Wall-complex. With a rich heritage in the north of England and lowland Scotland of enclosure[188] the earthworks would have been easily comprehensible to those indigenous to the landscape. The existence of crossing places provided emphasis for both the sacred nature of the structure as well as the active participation required to cross. That this act of crossing took place under Roman auspices was highlighted by passing though the archway of either a milecastle or fort. Here many symbolic associations were made, primarily related to subservience to Rome. This message was exacerbated by the use of the Wall as customs barrier, providing physical opportunity for the conversion of actions into *maiestas* by the soldiery.

The presence of the soldiery introduced Roman spatial ordering to the Wall. This both communicated and enforced the Roman concept of space onto those who passed through the milecastles or forts. Again, this evoked concepts of divine ordering but also that of civic and military identity. Passing out of the milecastles or forts provided opportunity for the restatement of the power imbalance first encountered upon entering the structure. Finally, on the south side, the vallum is encountered, its revetted turf ramparts provide

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[188] See §3.5.

Fig.6.19: Tomb of the Haterii, showing large crane used in construction.

the material rhetoric of building in turf that would otherwise have been missing from the Wall, post stone reconstruction of the turf Wall. Again, as with the ditch, crossing is emphasised and carries a similar message, however, greater stress is placed on the vallum-side due to the larger ditch and, importantly, the possibility of the gateways. Once again, this forces subservience to the reified concepts of Rome that these structures connote. Further reinforcement of previous concepts come in the shape of the revetted vallum mounds. The construction of the mounds, specifically their revetment, is connected to the display of technical skill and control over large resources as the revetment greatly increases the complexity of their construction.

Throughout the act of crossing the Wall, certain key themes recur. The use of stone throughout much of the structure is connected to the comparative difficulty of working in such a material. That this was an important propagandistic element can be seen in other Roman structures, the tomb of the Haterii, for example, shown on Figure 6.19, displayed images of the considerable effort required for its construction.[189] The act of repair, most notable on the earthworks, also rendered this link both visible and real. Indeed, this feature would be extremely prominent in turrets and milecastles towers, as the monumentality of the scaffold and lifting devices would have been made even more pronounced due to their great height. This would have created multiple types of impact, the building work which was then remembered and immanent in the resultant structure.

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[189] Thomas, 2007, 107, 184-5.

The power of this symbolism was such that construction may have been deliberately lengthened in order to maximise the power of this act. This is clearly highly conjectural, however, the quantitative results demonstrated that structures which housed units appear to be designed to be constructed in around one building season of 200 days. Often many more people than the garrison could fit on site during construction than appear to have been used.[190] Despite this, the chronology of the Wall shows construction taking place over a minimum of eight years. Whilst there are clear logistical reasons for this time-scale, it is also a possibility that there may have been symbolic reasons for the time taken.

It is not solely the Wall which took nearly a decade to complete, the basilica at Wroxeter in Shropshire, for example, took a similar amount of time. Its slow completion has traditionally been attributed to a lack of will or resources,[191] both of which are unlikely for a structure of this importance in the Roman world. Interpreting the structure's extended completion time as a deliberate act to highlight the importance of construction allows this process to become ingrained in the 'memory' of the landscape and the people within. This is concomitant with the many ways in which the Wall attempts to co-opt the physical landscape as a means to the end of making people become Roman. Such a process working on people's memories would give recurring building work, the recutting of ditches or the re-rendering of the curtain, a power which would make the Wall more than merely a structure but a site of both episodic and remembered cultural interaction and demonstrations of technical achievement. Albeit one predicated both on power imbalances and a quite literal building of new Roman landscapes.

What is the end-product of the building process and the resultant operational structure? There is a clear conflation of representing Roman *maiestas* and forcing subservience to Roman aspects of

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[190] See §6.5.2, Table 6.15, §4.8.3 and Shirley, 2000, 92.
[191] Thomas, 2007, 78.

civic and imperial identity within the structure of the Wall. Fundamentally, this is to make both space and people where the Wall is located 'Roman', or, at the very least, accepting the trappings of Roman power and material culture. Interestingly, British Roman cities tend not to have city walls at the time of the Wall's construction.[192] Consequently the heavy emphasis placed on the use of the curtain wall to connect the wall-forts, rather than a standard road, can be connected the aggressive promotion of this most Roman expression of culture.[193] This is clearly in order to expand Rome's influence and is not Hadrian letting the empire 'rest, at least temporarily, on its laurels'.[194] The key difference here is execution, whereas Trajan inspired fear, respect and gained expansion through direct Roman military action,[195] Hadrian adopted a different approach.[196] Rather than reaching beyond Roman borders with the army, he created structures at the very edge of Roman control to achieve the same goals as Trajan. This is the reason for the placement of Hadrian's Wall, it was not a defensive line, separating Roman from non-Roman, but an aggressive method of expanding the empire. Mann states that the Wall's archaeology is mesmerising, and attributes the meaning of the Wall to that of rhetoric.[197] However, he misunderstands the power and importance of rhetoric. Written text may only have been accessible to certain people, but rhetoric in physical form was available to all.

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[192] Esmonde Cleary, 2003, 80-4 includes a table showing the lack of settlements in Britain with walls at the time of the construction of Hadrian's Wall. The overwhelming majority were constructed in the late-2nd to early-3rd century.

[193] See §3.6; §6.6.2; Whittaker, 1997, 144-5, 148.

[194] Contra Mann, 1990, 51.

[195] Mattern, 1999, 118-9: 'peace could be insured only by aggression.'

[196] This also includes his use of the army to inspire fear through high-visibility military exercises, a tactic not overwhelmingly popular with the senatorial elite. Mattern, 1999, 121, 206-7; Fronto, *Principia Historiae* 10: 'These entire provinces, Dacia and the parts lost by the Parthians, Hadrian voluntarily restored. His armies in Asia he amused with "sallies" in the camp instead of with swords and shields: a general the like of him the army never afterwards saw.' Has omnes provincias, Daciam et Parthis amissas partes, ultro restituit. Exercitus in Asia se pro scutis atque gladiis salibus sub pellibus delectare: ducem neminem umquam post eiusmodi vidit.

[197] Mann, 1990, 51, 54.

VII | The Cumberland Coast

The very Turrets and Towers mentioned by Bede, to have been built by provincial Britons, contiguous to this Wall on the South-side of the shore, at regular Distances for defending the Coast from the Invasions of Scots and Picts; these very Turrets, last Summer, I had the Satisfaction to discover their Vestiges.

GORDON, *ITINERARIUM SEPTENTRIONALE*, 90.

§ 7.1 | Introduction

This chapter focuses on the Cumberland coastal system, the series of installations on the west coast of Cumbria after the termination of the Curtain Wall at Bowness-on-Solway. The Cumberland coast, however, is a very challenging area archaeologically; as will be discussed, a combination of materials and environment have rendered the schedule of sites, shown on Figure 7.1, difficult to determine. These problems have not only made the extent of the system debatable, but also affected the survival of many of the installations. Nevertheless, the study of the Cumberland coast is relevant to understanding the purpose of Hadrian's Wall, both physically and in terms of interpretation, due to its connexion with the Wall and their broad similarities in anatomy. Thus the coast is assessed in terms of function, constructional vocabulary as revealed by the quantitative survey, and its symbolic connexions to the Wall. Finally, the historiography of the Cumberland coastal system is important in understanding broader interpretations of the Wall.

§ 7.2 | Schedule of Sites and Environment

The Cumberland coastline is not conducive to the survival of turf and timber structures, wind and coastal erosion have caused patchy survival across the study area. Most notably this is seen with the milefortlets, a mere five of which survive in enough detail to be considered for the quantitative survey.[1] Environmental difficulties in this area are not just the curse of the modern archaeologist, there is evidence of Roman difficulties in constructing and building in such an environment. The foundations of CT3b, 12a and 16a, which form more than a quarter of the quantitative sample group, are sunk to a depth of *c*.1m. The Wall's structures often forego foundations. Similarly, the ditches which appear on the Cardurnock peninsula required multiple re-cuts,[2] doubtless due to the soil conditions, inundation and wind deposition.[3]

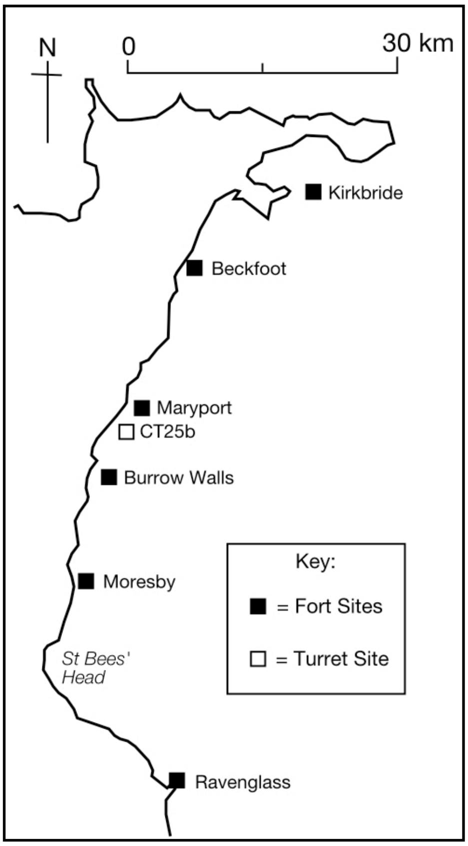

Fig. 7.1: The different extents of the proposed systems for the Cumberland coast.

These environmental issues effect the interpretation of the Cumberland coastal system as they obfuscate the true extent of the schedule. Birley, with the assistance of Richard Bellhouse, proposed a system stretching as far as St Bees' Head comprising 40 'coast miles' with four main forts, Beckfoot, Maryport, Burrow Walls and Moresby.[4] Potter suggested a system as far south as Ravenglass fort and possibly beyond.[5] The different extents of these alternative systems are shown on Figure 7.1.

The evidence on the ground, however, does not support either of these large-scale systems. Birley's proposal, of a termination at St

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[1] Numbers 1, 5, 20, 21 and 22.

[2] Jones, 1976, 243; Bellhouse, 1981a, 137.

[3] Jones, 1976, 240.

[4] Birley, 1961, 127-8. Birley here stresses that the forts and installations of the Cumberland coast are, in fact continuations of 'the same basic system of military support for the frontier-control line'. The use of a different numbering system for the towers of the Cumberland coast is in order to maintain convention with older reports. The forts, excluding pre-Hadrianic Maryport, are given concurrently running numbers from the Wall series to emphasise this connexion, and are covered in Birley's later section in RHW detailing the Wall forts. *Ibid*., 214-26.

[5] Potter, 1979, 14, concludes that there is 'a good case for suggesting an extension of the Cumbrian Coastal *limes* down to Ravenglass and indeed beyond'.

Bees' Head is not supported by the interval structures, none of which can be found south of CT25b. Ravenglass' claim to integration with the coastal system cannot be supported due to its isolation from the interval structures, being cited some 40km away from CT25b. Ravenglass fort, however, supersedes a Hadrianic milefortlet,[6] dated A.D.120-130, which sees the site integrated into Potter's coastal model terminating at Morecambe Bay, near Barrow-in-Furness.[7] This is some 30km south of Ravenglass, and almost 70km from CT25b, the nearest archaeologically attested part of the coastal system. Consequently, a termination of the system at CT25b will be presumed in this study. That the system ends with a tower is, perhaps, surprising,[8] though it must be stressed that this would be commensurate with the planning of the Wall, which did not originally integrate forts. Similarly, it is unlikely that military force would be concentrated at the periphery of a system in an area of low need. A termination at CT25b had the benefit of a wide viewing aspect which is more evident when compared with the comparatively poor views offered by the southerly forts at Burrow Walls and Moresby.[9] Finally, choosing to use only the archaeologically attested areas is in line with the the project methodology of assuming the minimum when there is significant doubt.[10]

§ 7.3 | Traditional Approaches

The concentration on anatomy that dictates many Wall interpretations has also been applied to the Cumberland coast. There is more than a broad equivalence between the Wall and the installations south of the Solway: the tower and milefortlet system,

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[6] Blood, 1999, 6.
[7] Potter, 1979, 359.
[8] Contra Potter, 1979, 359; Blood, 1999, 15.
[9] Breeze, 2006, 408.
[10] See §4.3.

for example, can be observed throughout the sample area[11] and is a continuation of the Wall's milecastle and turret arrangement. Furthermore, with stone towers and milefortlets of turf and timber, the building materials of the coastal system reflect those of the turf wall. Similarly, the presence of forts at Kirkbride, Beckfoot and Maryport mirrors the forts along the line of Hadrian's Wall. Finally, the continuation of linear works can be seen in the double ditch present across the Cardurnock peninsula near MF1, CT2b and CT4b.[12]

This anatomical similarity has resulted in the application of the same interpretation of functions to the Coastal system and Hadrian's Wall. Thus, as with Alexander Gordon's analysis of the early-18th century, which opens this chapter, the primary goal of the system is seen to be to defend the west coast, as Hadrian's Wall defends the Tyne-Solway isthmus. Potter's analysis demonstrates how little the core idea has changed over the intervening centuries:[13]

> At the same time the curtain was extended down the vulnerable low-lying coastal plain of north-western Cumbria by the construction of a chain of milefortlets and turrets together with the forts of Beckfoot, Maryport, Burrow Walls and Moresby. […] How far this system may have been continued is unknown, but it would be surprising, given the topography of south-west Cumbria, if it was not carried on to Millom or even Barrow-in-Furness. It is a most striking indication of the enormous lengths to which the Romans were prepared to go to protect the western flanks of their frontier from sea-borne attack.

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[11] This had been cause for some debate, e.g. Bellhouse, 1989, 54 believing their had been some sort of 'dislocation' in construction due to the pre-Hadrianic existence of Maryport fort. Daniels, 1990, 404-6, concludes that Rise How should be identified as a tower, not a milefortlet, thus giving the correct spacing and sequence to maintain the system.

[12] Jones, 1976, 237. The lack of curtain or vallum type structures

[13] Potter, 1979, 359.

However, there are indicators that the organisation and anatomy of the coastal structures differs from that seen on the Wall, most obviously the Curtain Wall is not continued. Thus, does the core principle of the coast being like the Wall still stand? This is all the more relevant given that military functions may not have been the prime factor in the purpose of the Wall.[14]

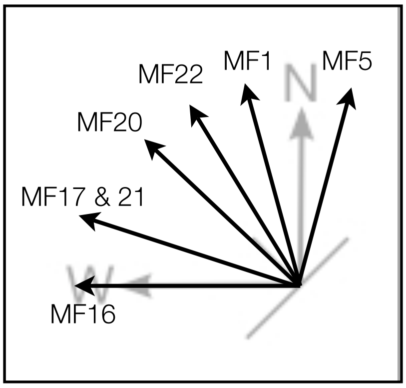

Fig. 7.2: The variable orientations of the milefortlets.

The milefortlets of the coast have a key difference from the milecastles of Hadrian's Wall: their orientation. Those on the Wall uniformly face 'away' from the province to the north to allow traversal of the Wall's line. The coastal system's milefortlets also follow this general rule,[15] with the exception of MF5. This fort, in facing north, is the only milefortlet which does not face 'away' from the province. This is unparalleled on coast and Wall alike. The variability in orientation is shown on Figure 7.2. Furthermore, whilst the topography is more variable, the milefortlets respond to local conditions in a way not often seen on the Wall, e.g. MC35's non-existent north gate[16] implies an inflexibility in milecastle placement not reproduced on the Cumberland coast.

Similarly, whereas the Wall possesses a ditch to the north and the vallum to the south, the Cumberland coast has ditches of a design and type alternate to those found on the Tyne-Solway isthmus. These ditches, attested archaeologically around the Cardurnock peninsula[17] at sites near MF1, CT2b and CT4b, measure 1.1-2m across, *c*.0.75m deep with a *c*.0.5m sump. Two ditches run parallel and are set some 30-45m apart. Within this area the 'interval' structures are sited. The form of the ditches, including their minimum/maximum values, is shown on Figure 7.3.

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[14] See Chp.6.

[15] Potter, 1977, 151 for MFs 1 & 5; MF20: Bellhouse, 1970, 23-7; MF21: Turnbull, 1998, 64; MF22: Bellhouse, 1970, 10-3.

[16] Breeze, 2006b, 228-9.

[17] Jones, 1976, 237. Whether the ditch extends across the whole of the system cannot be determined due to the conditions.

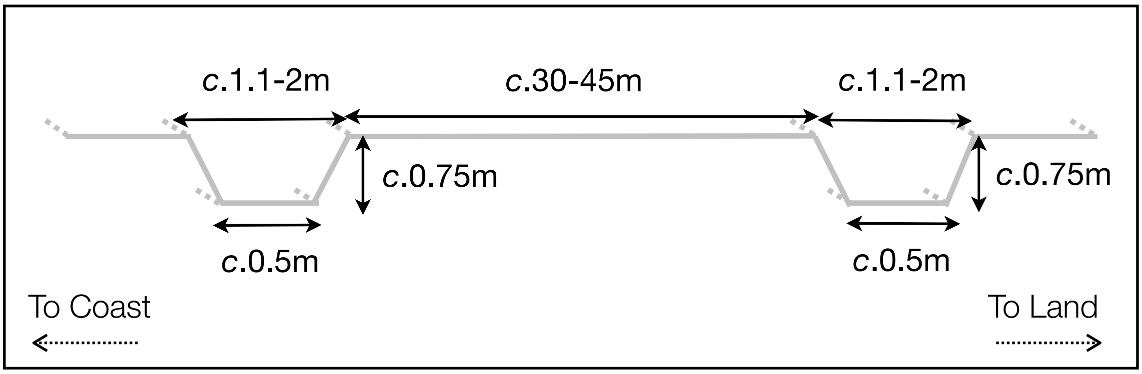

Fig. 7.3: Anatomy of the coastal ditches. Not to scale.

Superficially there are some similarities with Hadrian's Wall, naturally the ditches are comparable, and the parallel ditches of the Cumberland coast recall the distance between the vallum's two mounds. However, the differences appear to be fundamental, with the milefortlets facing multiple different directions it can be seen that they were not present to allow traversal of the line in the same way the milecastles provided access through the curtain wall. Similarly, the milefortlets facing the coast do not straddle the ditches in the same manner that the milecastles span the line of the curtain wall. The coastal ditches themselves are half the depth of those seen on the Wall, though some of this disparity can be attributed to the markedly different building conditions on the coast.

Whilst the interval structures do have superficial similarities with the Tyne-Solway installations there are fundamental differences between the Cumberland coast and the Wall in terms of anatomy, and presumably, function. Does the quantitative survey provide emphasis for similarities or differences between the Cumberland coast and the Wall?

§ 7.4 | Quantitative Survey: Towers

The coastal towers are similar in form to those of the Turf Wall in that they are not designed to be recessed into a stone wall. The primary difference is that the conditions on the coast require a much deeper foundation cut. This can be seen in the metre deep foundations of CT3b, CT12a and CT16a. Due to the importance of such deep wall foundations to material volumes and labour, these are included in the calculations for these towers. The height projections for the towers are of variable height Types I, II and III, commensurate with the project methodology.[18]

The results of the quantitative survey, for Type I towers are shown on Table 7.1:

Table 7.1		
Tower	Work Rate	Cost
3a	480.79 person days	£142,592.59
3b	550.52 person days	£163,273.78
12a	530.89 person days	£157,450.93
13a	596.01 person days	£176,764.11
13b	586.23 person days	£173,865.06
15a	500.29 person days	£148,376.27
16a	575.02 person days	£170,537.58
16b	465.73 person days	£138,125.24
20b	593.82 person days	£176,115.16
21b	533.33 person days	£158,175.68
25a	505.53 person days	£149,928.88

Table. 7.1: Labour and cost of coastal towers.

In comparison with the turrets of the Turf Wall, the Cumbrian towers require marginally more labour, which is reflected in their total construction cost. This is shown on Table 7.2:

Table 7.2		
Group	Average Work Rate	Average Cost
TW Turrets	523.41 person days	£146,335.89
CC Towers	538.02 person days	£159,564.17

Table. 7.2: Coastal tower averages compared to turf wall turrets.

The similarities between the two groups can be seen in terms of cost, *c*.10% difference, and in labour, *c*.3% difference.[19]

[18] See §4.5.2. For quantitative survey of towers see §A3.4-6.

[19] Exact cost difference, 8.29%; exact work rate difference, 2.72%.

The coast's towers are closely related to the turf wall's turrets as neither recess into a curtain. They deviate by a value of 46.24 (8.59%) compared to the turf wall's value of 79.19 (14.12%), thus the sample group is more internally consistent, though all these differences are so small as to be indistinguishable on the ground.[20] The close connexion in terms of work rate demand and cost suggests the towers of the Cumberland coast and those on Hadrian's turf wall had the same structural vocabulary.

Given this similarity, can any of the hypotheses relating to the Wall be applied to the coastal towers? Sequencing, the alternation between 'large' and 'small' can be examined in terms of labour demand rather than the traditional method of size.[21] The most complete chain of structures is that of CT12a and CT13ab, clearly CT12b is missing from this which renders much discussion impossible. It should be noted that CT13ab are very close in terms of cost, unlike the other surviving 'pairs' ofCT3ab and CT16ab, this difference between the three pairs of towers intimates that such sequencing does not occur.

Furthermore, the ascription of 'legionary' building lengths, traditionally ascribed through doorway locations, encounters difficulties due to their lack of survival in many of the towers. Currently, there is evidence for only two towers with doors placed in the eastern wall, on the north side at CT13b and CT15a.[22] There is some circumstantial evidence for a south entrance in towers at CT12a, CT16b and CT25a,[23] though not enough to assign building lengths with certainty. The broad uniformity in size reflected by the standard deviation and the possibility of two different building styles intimated by the door placement, implies the use of fewer building teams. Certainly, the less expansive nature of the Cumberland coast

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[20] The stone wall shows an even greater deviance of 107.71 (20.15%).
[21] Hill & Dobson, 1992, 38.
[22] CT13b: Robinson, 1881; CT15a: Bellhouse, 1954.
[23] CT12a: Bellhouse, 1969; CT16b: Bellhouse, 1954; CT25a: Bellhouse, 1984.

compared to the Wall makes this hypothesis likely, though not certain.

§ 7.5 | Coastal Milefortlets

The erosive powers along the coastline can be seen clearly when considering the milefortlets. With a sample group potentially of 22 a mere five survive. Milefortlets 1, 5, 20, 21 and 22 give just enough of an insight to provide a general picture. The turf and timber structures of the milefortlet are surveyed in line with the project methodology[24] with Type I and II turf structures being calculated comparatively and concurrently. For the presentation of results the comparison takes place between Type I structures, the lowest figure.[25] The results of the quantitative survey can be seen on Table 7.3 in comparison with the milecastles of the turf wall:[26]

Table 7.3		
Structure	Work Rate	Cost
MF 1	3,607.99 person days	£587,136.87
MF 5	6,509.05 person days	£1,065,099.56
MF 20	3,487.10 person days	£566,066.10
MF 21	3,409.45 person days	£555,008.30
MF 22	4,660.60 person days	£759,788.02
MF Average	4,334.84 person days	£706,617.57
TW MC	2,895.80 person days	£472,877.85

Table 7.3: Coastal milefortlet labour and cost compared to turf wall milecastles.

Some broad conclusions can be drawn from the data. First and foremost is the relative sizes of the two groups. Clearly, the smallest milefortlet, MF21, is more demanding than both the turf wall milecastles. Similarly, the largest milefortlet, MF5, is more than twice as labour intensive as the turf wall average. This evidence alongside the variable axes of the milefortlets, shown on

24 See §4.6.1.

25 See §4.3.

26 For milefortlet quantitative survey see §A3.7-9.

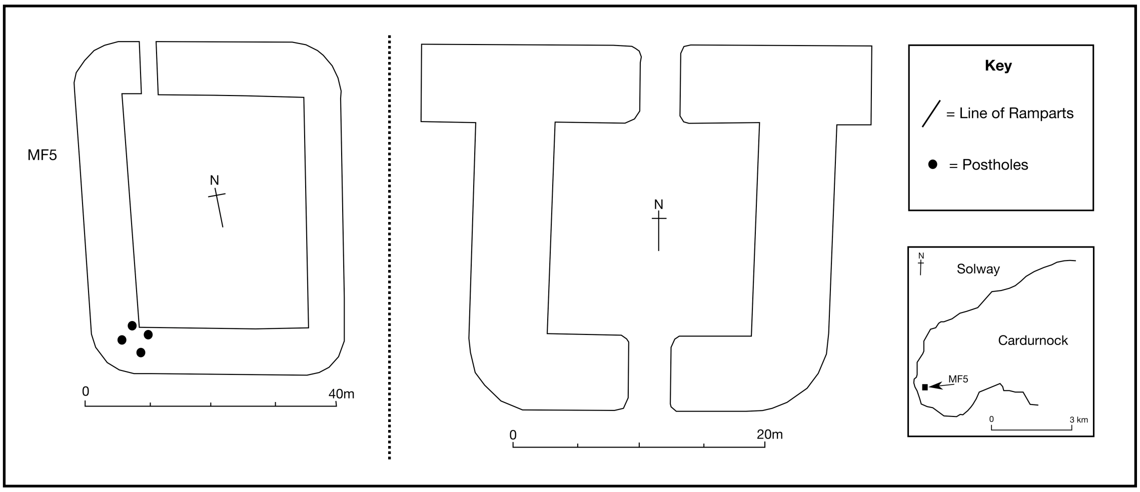

Fig. 7.4: The form of MF5 compared to TW milecastles.

Figure 7.2 supports an interpretation where the milefortlets are different in terms of size and function with their equivalents on Hadrian's Wall.

This dislocation in terms of function is highlighted when considering the detail of milefortlet layout. MF5, Cardurnock,[27] is one of the earliest complete milefortlet excavations and shows divergent characteristics. Firstly, this milefortlet is orientated north to south, the same way as the Wall's milecastles. However, the resemblance between coast and Wall is not carried over to the gateways: at MF5 the gateway is off-centre, a layout without parallel on Hadrian's Wall. Furthermore, there is only one gateway. MF5 is situated on a saliant and the gateway does not face 'out' of the province. Movement through the structure in the manner seen on the Wall consequently cannot be the underlying reason for this installation. A comparison between the typical form of a turf wall milecastle and MF5 can be seen on Figure 7.4, alongside a map of MF5's peninsula location.

A more subtle indicator of the difference in role of these structures is that of the tower. MF5 has only one entrance, and is therefore not used to allow the crossing of an obstacle. Towers, which on the Wall's milecastles emphasise the entrances, are no longer needed to fulfill this role.[28] Consequently, on MF5, the tower of the structure is

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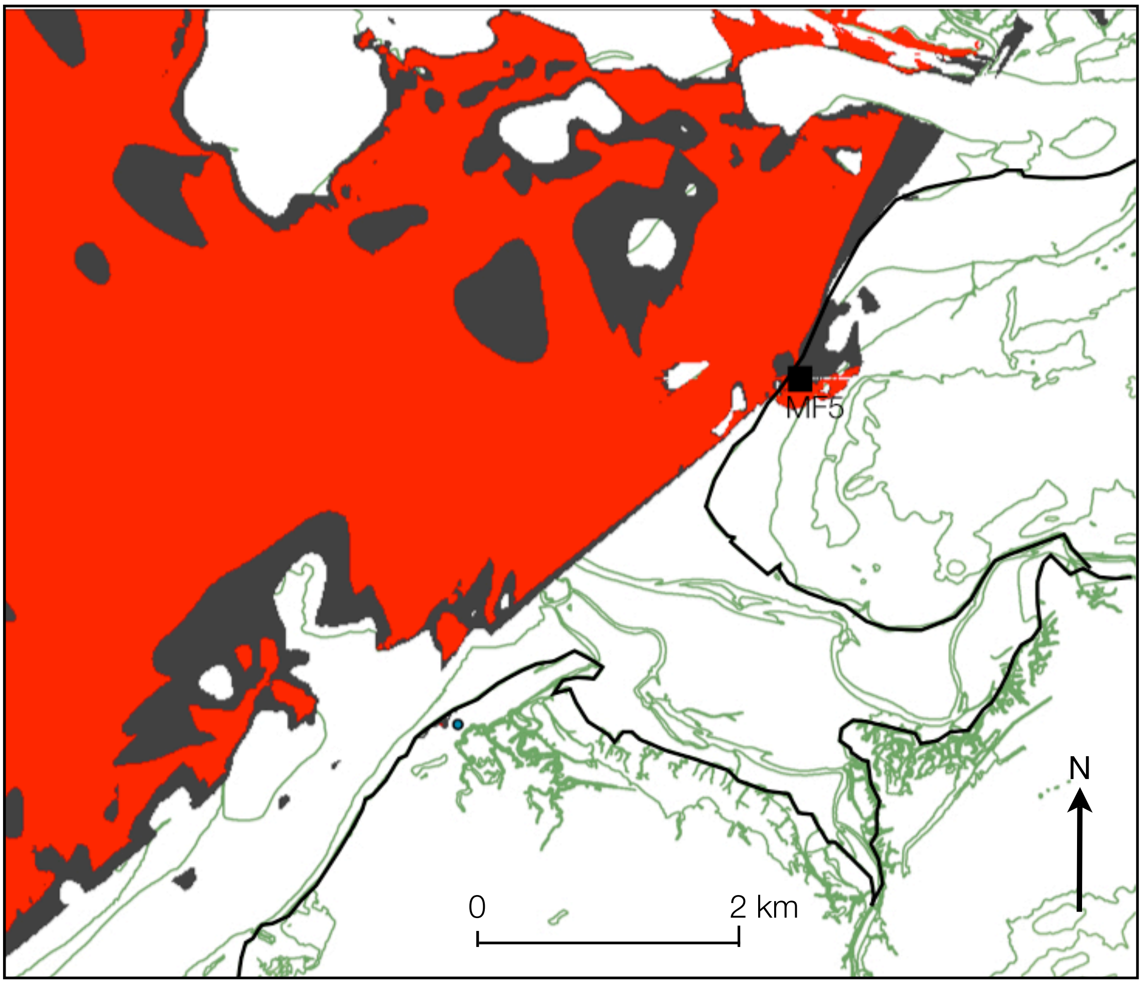
[27] Simpson & Hodgson, 1947.

[28] The form of MF5 underlines the connexion of towers to the role of movement on Hadrian's Wall itself. Similarly, this reinforces the argument for towers on both the north and south walls, as movement would not have only been in one direction.

on the south-west angle, as shown on Figure 7.4. Importantly, given the position of MF5 on a promontory of the Cardurnock peninsula, the presence of the tower would serve to highlight the physical presence of the Romans and their structures. This is shown on a comparative viewshed, Figure 7.5, contrasting the site of MF5 with a Type I tower to the site without. The red shows the site without a tower, whereas the grey demonstrates the gains made by a full



tower.

Fig. 7.5: Viewshed of MF5's site and the full tower height of the structure. Red for site; grey for tower.

Evidently, the ground upon which MF5 was located is highly visible, the tower itself adds very little in terms of visibility. Importantly, this is almost exclusively maritime and not in-land, unlike the Wall which is often equally visible from north and south. Furthermore, the tower height emphasised the visual prominence of the structure directly northwards of its position, the direction its sole access faces. Seemingly, MF5 was to be seen by those trying to

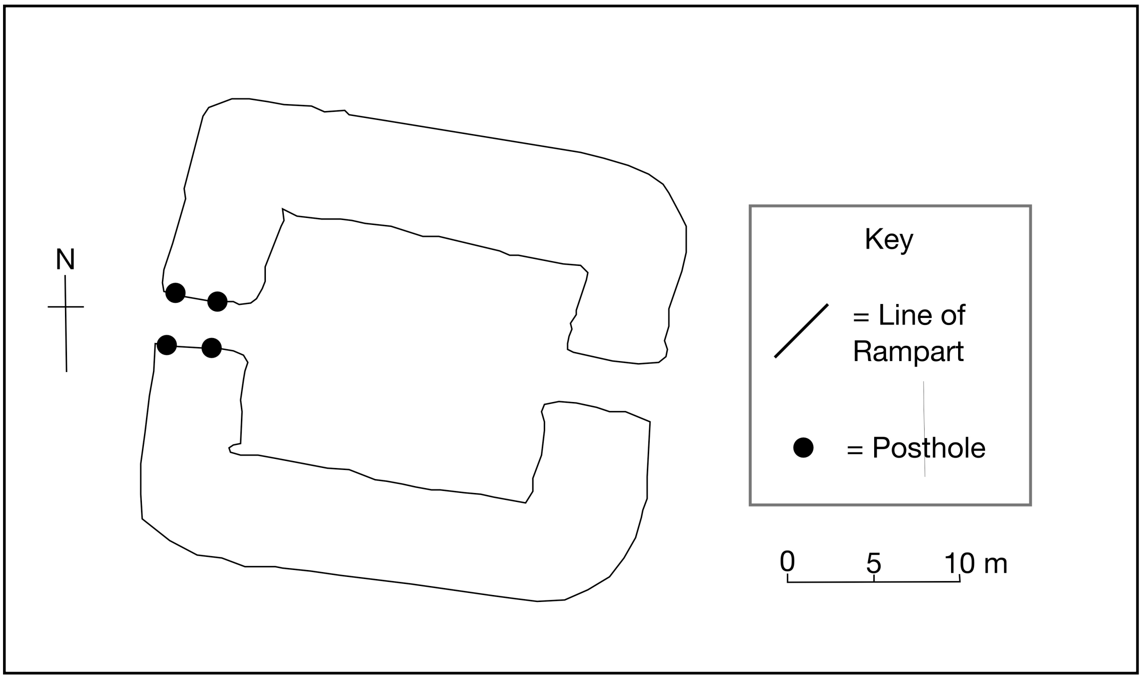


Fig. 7.6: Plan of MF21, showing evidence for a substantial seaward tower.

cross the Solway Firth, and to watch over the immediate environs of the site. This is a further difference from the Wall, which is equally visible from both north and south.

Similarly, close inspection of MF21 reveals differences in the two access ways of this structure which intimates that movement was not its raison d'être. Figure 7.6 demonstrates that the eastern landward gateway shows signs of having a timber gate; whilst its western, seaward, counterpart is altogether more substantial providing a gateway and timber tower at least one storey above the rampart based around four large post-holes.[29] If traversal was the key part of such a structure, both sides, it is assumed, would be in equal use and thus should be reflected by a commensurately balanced array of towers. Consequently, even when two entrances are present and orientated along a central axis it can be seen that movement was not the main purpose of these structures on the Cumberland coast.

Having seen the structural evidence for how milefortlets differ from the Wall's milecastles, this begs the question of their actual role. As noted,[30] Cumberland structures are traditionally seen as extensions

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[29] Turnbull, 1998, 71-2. Milefortlet sites normally used six post-holes.

[30] §7.3

of the defensive purpose of the Wall, securing the western coast. However, the application of the Wall's function is based upon the Cumberland coast's role as a simple extension of the Wall which can be seen in the debate about the separate numbering sequence.[31] However, the different nature of the Coastal installations would appear to undermine this: they are, fundamentally, different in form and presumably function. Consequently, the reanalysis of Hadrian's Wall as a symbolic structure[32] actually reinforces the functional aspects of the Cumberland coast. This is not because, as previously thought, it was a mere continuation of the Wall's form, but precisely because it was anatomically different from the intentionally overly-symbolic nature of the Wall. The responsiveness to local factors, for example, is a key aspect of the Cumberland coast, and a vital part of a militarily functional structure that is not seen on the Wall.[33]

The broader Roman context demonstrates that it is the Wall's installations, not the Cumberland coast's, which are unlike standard Roman military structures. Such nearby examples as Longshaws in Northumberland, and further afield at Degerfield in Germany,[34] demonstrate that the form of sub-fort structures was more similar to the Cumberland coastline's structures than to those on the line of Hadrian's Wall. Such structures are, on the whole, variably aligned due to their need to meet local conditions, and possessing only one access way, as at MF5. This highlights Hadrian's Wall's structures as anomalous in much of the Roman world. It is, in fact, the Cumberland coast infrastructure that closely resembles the standard answer to questions posed all over the empire.

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[31] This was settled by Birley, 1961, 128: 'On many grounds it seems desirable to offer a schedule of the coastal sites, drawn up in a similar way to that of the Wall-sites but retaining the new numbering - from 0 at Bowness - which has established itself in general use (rather than numbering on from 80).'

[32] See Chp. 6.

[33] Dobson, 1986, 5-7; Mann, 1990, 53.

[34] For Longshaws see St Joseph, 1969, 106; Degerfield see Schönberger, 1969, 165, fig.18.

§ 7.6 | Coastal Forts

Despite the presence of many forts on the coast, only Beckfoot and Maryport are contemporary with the construction of the Wall. Burrow Walls is a much later 4th century foundation.[35] Similarly, Ravenglass is later than the Wall and the coastal system, only the phase 0 fortlet is contemporary.[36] However, lack of interval structures continuing to Ranvenglass means that this site, presumably, does not belong to the system. Similarly, the inclusion of Moresby to the Cumberland coat, despite being commensurate with the era and constructed by the same units as the Wall, can be doubted as it is located some 15 km south of the milefortlet and tower installations. Kirkbride, the most northerly fort in the sample group, is an earlier foundation similar in date to the forts on the Stanegate.[37] Sadly, little of Kirkbride remains and thus it cannot be accurately included in the quantitative survey, furthermore, the fort seems to have been abandoned with the construction of the Wall and coastal system.[38]

This leaves a mere two forts with secure dating and archaeological evidence for inclusion as part of the Cumberland coastal system. The inscriptional record shows that Moresby fort was constructed by *legio XX Valeria Victrix* and the use of *pater patriae* as an honorific for Hadrian dates this to A.D.128-138.[39] Due to the small quantitative group, Moresby is included in the discussion and for averages, though not for overall manpower calculations relating to the Wall and its associated sites.[40]

The use of stone for the coastal forts is a difference from the form of the turf wall and indicates that broader contexts must be

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[35] Breeze, 2006b, 96, 410.

[36] The fortlet was demolished and replaced by a fort in the late Hadrianic period, Potter, 1979, 19, 28-9.

[37] Breeze, 2006b, 469.

[38] Breeze, 2006b, 50, 469. Pottery dates from A.D.80-120/5, with later occupation implied by a coin of Tetricus I, A.D.270-4.

[39] Breeze, 2006b, 411.

[40] See §A3.10-5 for fort quantitative survey.

considered. The use of stone allows direct comparison with the forts in the east, and the re-worked west, of Hadrian's Wall, as well as casting some light on the chronological development of the area. The fort decision on the Wall developed in two distinct phases: firstly, the placements of forts in materials congruous to their locations (stone in east; turf and timber in west); secondly, the replacement of turf and timber with stone. The lack of turf predecessors on the sites of the coastal forts implies that the fort decision in this area belongs after the completion of the first phase, otherwise turf and timber forts would have been built; but before the commencement of the second, as the milefortlets are not rebuilt in stone as was the case with the milecastles of the turf wall.[41] This is reinforced in the chronology with the commencement of the Cumbrian coastal forts taking place congruently with the stone re-building of the western Wall in A.D.128-38.[42]

The results of the quantitative survey are shown on Table 7.4:

Table 7.4		
Fort/Group	Work Rate	Cost
Beckfoot	88,356.56 person days	£24,952,763.16
Maryport	126,305.82 person days	£34,630,059.11
Moresby	72,158.78 person days	£19,758,640.03
CC Average	95,607.05 person days	£26,447,154.10
SW Average	112,431.11 person days	£32,474,776.36
TW Rebuild Average	120,836.86 person days	£33,252,916.23

Table 7.4: Cumberland coastal forts compared with turf wall rebuild and stone wall.

As can be seen, the Cumberland coastal average is lower than the Wall's forts. Since the coastal forts appear to owe their existence to the same period as the turf wall's reconstruction in stone, the most natural comparison would be between these two groups. However, these show the greatest disparity in terms of work

[41] Potter, 1979, 29, cites the A.D.130s as the inception of the coastal forts, once those of the Wall had been completed.

[42] Breeze & Dobson, 2000, 86-7, Table 7.

rate and cost. As with the milefortlets and milecastles, this divergence could intimate a different purpose from the Wall forts. Even with the removal of Moresby from the sample group the average work rate and cost would still be below those of the stone and turf wall, the latter notably so.[43] Similarly, the spacing between the forts in the coastal group differs from the Wall. With a distance between Kirkbride and Beckfoot of some 16km, and 14km between Beckfoot and Maryport, the distances between forts are much greater on the coast than the Wall.

In terms of size, Maryport is virtually unrivalled on the Wall, only exceeded by Stanwix's stone re-build.[44] Bowness-on-Solway is relatively similar in terms of size to Maryport.[45] Within the coastal group Maryport is the only *milliary* fort. Both Beckfoot and Moresby are still substantially smaller than other comparative installations on both the stone and turf wall. This would certainly imply that the Cumberland coast was a low priority area, with just one *milliary* and one *quingenary* fort to support the area. Nevertheless, its role was clearly important enough to warrant the maximum disposition of some 1,500 soldiers and the construction of interval structures.

This raises the simple question: why is there a difference between the coastal system and Hadrian's Wall itself? Undoubtedly the military vocabulary is very similar, both the towers and the forts can be seen to be very similar in form, though the latter not in size, to those of the Wall. The milefortlets stand out for their normality in comparison with the atypical form of the Wall's milecastles. Undoubtedly a picture is beginning to emerge of the differences between the structures of the Cumberland coastline and those on the line of the Wall, be they turf or stone.

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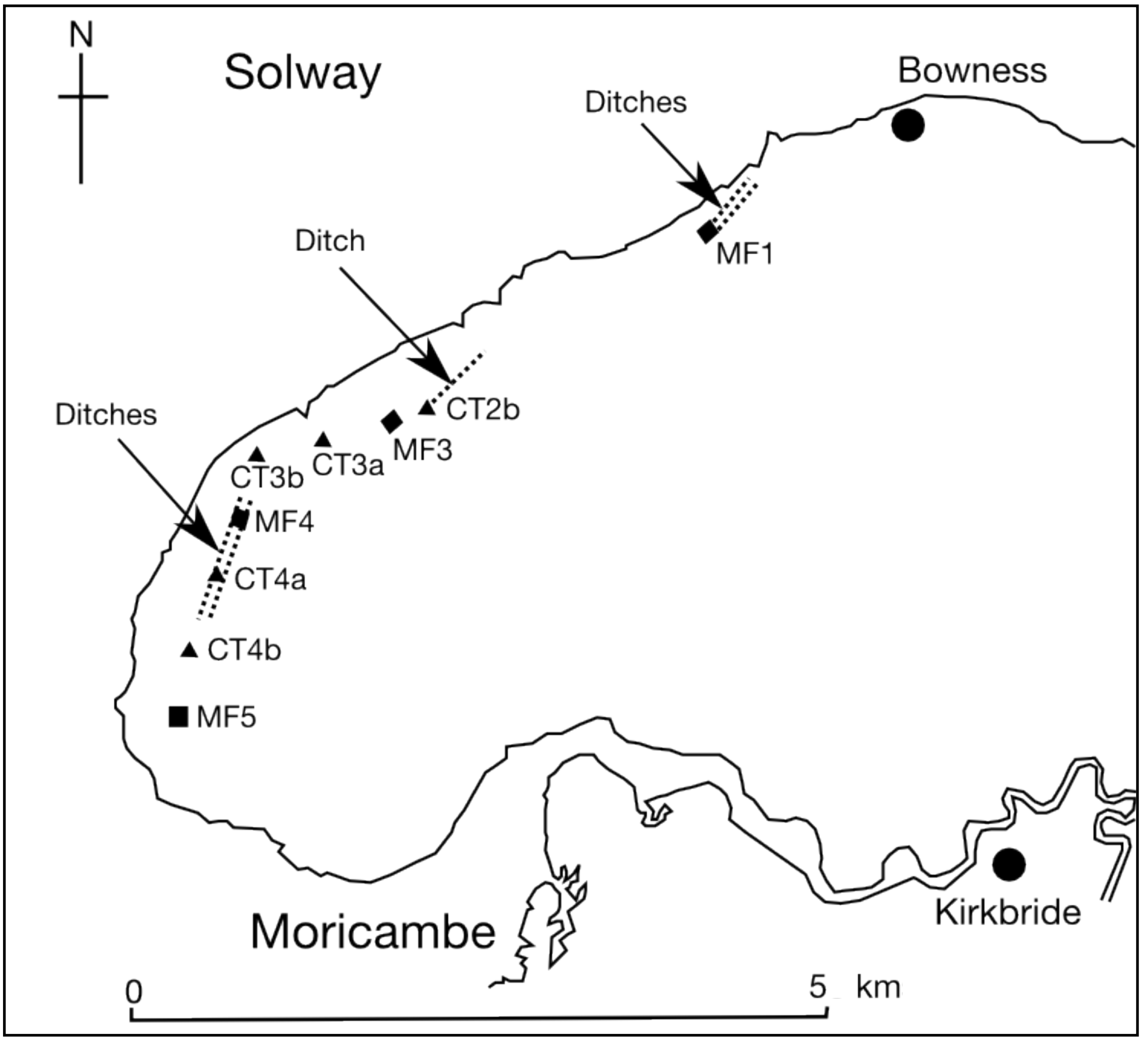
[43] 107,331.19 person days would be the average without Moresby, with the propable-contemporary turf wall rebuild showing the greatest difference of all comparanda.

[44] Stanwix outstrips the size of Maryport by approximately 20% in terms of area, *circa* 9,000m^2 larger than Maryport's 27,040m^2.

[45] This demonstrates something of an western bias when it comes to exceptionally sized forts. This may well be connected to the fact that these stone forts come later than those in the east.



§ 7.7 | The Ditches of the Cardurnock Peninsula

Fig. 7.7: Map of Cardurnock's ditches.

The ditches of the Cardurnock peninsula are anatomically the closest structure to a linear barrier on the Cumberland coast. The form of the ditches, shown on Figure 7.3, differs from those on the Wall. Their spacing is reminiscent of the vallum, whilst their shape and size is connected to the ditches just north of the Wall. Evidence for the ditches is limited to a mere three areas on the Cardurnock peninsula, shown on Figure 7.7.[46]

This poor rate of survival means that projections need to be made for the peninsula. The ditch dimensions are presumed to run from their site of discovery along the peninsula until other evidence is found. Thus, the dimensions of the ditch found at MF1 are assumed to run from Bowness to the beginning of the ditch at CT2b; then, the

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[46] Jones, 1976, 237.

next ditch runs from CT2b to the start of the ditches at CT4b; finally, the last area continues from CT4b to MF5.[47] The results of the quantitative survey of these projections are shown on Table 7.5:

Table 7.5				
Zone	Length	Volume	Work Rate	Cost
MF1 North	3,500m	2,590m^3	323.75 person days	£149,572.50
MF1 South	3,500m	1,925m^3	240.63 person days	£111,168.75
CT2b North	2,250m	652.5m^3	81.56 person days	£37,681.88
CT2b South	2,250m	697.5m^3	87.19 person days	£40,280.63
T4b North	1,500m	1,218.75m^3	152.34 person days	£70,382.81
T4b South	1,500m	924.38m^3	115.55 person days	£53,382.66
Total	13,500m	8,008.13m^3	1,001.02 person days	£462,469.23

Table 7.5: Estimated labour and cost of the Cardurnock ditches.

As can be seen, the Cardurnock peninsula's ditches would take some 1,000 person days and cost *c*.£500,000. The vast majority of the cost, some £320,000, is the earth to be moved. These figures need inflation due to the evidence of two, sometimes three, recuts.[48] These may have been 'marking-out trenches', indicators of the line for the working parties.[49] The recuts appear more diminutive, possibly due to the coastal conditions, or because they were originally smaller. An estimate three times the result of the quantitative survey may be assumed for the total cost of the ditch system. The coast ditches' smaller scale compared to the Vallum and Wall ditch results in a much lower work rate demand and cost. Though the ditch is only archaeologically verifiable on the Cardurnock peninsula, projections are also made in the next section for 'whole system' ditches across the entire study area to CT25b.[50]

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[47] See §A3.2-3 for coastal ditch quantitative survey.

[48] Jones, 1976, 243; Bellhouse, 1981a, 137.

[49] Bellhouse, 1981a, 137, 139.

[50] Two milefortlets south of Moricambe have both front and rear entrances. Whilst this is not necessarily evidence of a running barrier to the south, as the *Kleinkastelle* in upper Germany have shown, Daniels, 1990, 403, it would be in line with the form of the Wall's milecastles. However, MF5 does not have two access ways, yet is sited near the ditches of the Cardurnock peninsula.

§ 7.8 | The Cost of the Coast

This section considers the total outlay in terms of labour and fiscal cost required to build the Cumberland coastal system as far south as the known limit. Whilst the surviving archaeology can give some guide to how far south the system projects, the ditches pose a different problem. These only occur on the Cardurnock peninsula, even though installations can be found some 20 'coast miles' south. As a consequence, two projections will be made: the first with ditches only where they are archaeologically verifiable; the second, with ditches stretching the length of the sample group and encompassing all the installations. The number of installations is shown on Table 7.6:

Table 7.6			
Installation Type	Surveyed	Proxied	Total
Towers	11	33	44
Milefortlets	5	17	22
Forts	2	0	2
Total	18	50	68

Table 7.6: Number of installations surveyed and proxied.

The 18 sites surveyed, from a possible 68, highlights how few Cumberland coastal installations have survived in sufficient detail to be included. The outcome of the quantitative survey can be seen on Table 7.7, the ditches category assumes Cardurnock peninsula coverage only:

Table 7.7		
Installation	Work Rate	Cost
Towers	23,672.67 person days	£7,020,821.11
Milefortlets	81,034.57 person days	£13,211,846.39
Forts	226,386.52 person days	£59,582,822.27
Ditches	3,003.06 person days	£10,387,407.69
Total	334,096.82 person days	£90,202,897.46

Table 7.7: Total labour and cost of the Cumberland coast.

This gives a total of *c*.335,000 person days for the whole system, assuming ditches were only placed on the Cardurnock peninsula. Expanding these to cover the whole system results in a total labour demand for the ditches of 13,213.46 person days, inflating the total labour demand of the Cumberland coast to 344,307.22 person days. With such light demands the ditches are not a labour intensive structure and thus their extent does not affect the completion time of the coastal system to any great degree.

According to the accepted chronology, completion of the coastal system occurred *c*.A.D.125 after some three building seasons.[51] In order to complete within this chronology *circa* 600 men, or little less than one *milliary* unit, would be required.[52] The differing demands the variable extent the ditches placed upon labour is summarised in Table 7.8:

Table 7.8		
Category	Work Rate	Complete in 3 Seasons
Cardurnock Ditches	334,096.82 person days	556 persons
Whole System Ditches	344,307.22 person days	573 persons

Table 7.8: Labour cost of 'whole system' and Cardurnock ditches.

Such low labour demands mean that the system could be built by a single unit in three seasons. This dovetails neatly with the lack of variation seen in tower construction.[53] Even an extension of the system as far south as St Bees' Head, as originally suggested by Birley,[54] would merely double the labour demand, and could thus be met with two units instead of one. With such light labour costs, soldiery could be freed up to work on more labour intensive areas. This highlights how an holistic interpretation of Hadrian's Wall and its ancillary sites is needed to fully understand the impact the complex had in the landscape.

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[51] According to the project methodology this totals 600 days, see §4.8.1.

[52] There is one milliary unit attested on the coast, that is Maryport's garrison. Jarret, 1976, 21.

[53] Supra, §7.4.

[54] See §7.2 and Birley, 1961, 127-8.

§ 7.9 | Conclusion: Function and Meaning

Close examination of the anatomy of the coast's structures has revealed a number of significant features. Primarily, there is a lack of uniformity in the relationship with the Wall: some structures appear to be almost exactly the same as those found on the Tyne-Solway isthmus, others are structurally and anatomically distinct. Firstly, however, there is the broad question of whether the Cumberland coastline infrastructure is a continuation of the Wall. In terms of the installations, there are good grounds for this case, the continued and repeated application of two towers interspaced by structures designed to house men is directly connected to the form of Hadrian's Wall. Similarly, the forts at Beckfoot and Maryport, appear to show that they were later additions in-line with the fort decision on the Tyne-Solway isthmus. Finally, the close equivalence of the coastal towers in form and quantification with the Wall's turrets demonstrates that the same structural vocabulary was used. Thus, the hypothesis that the coast was a broad continuation of the Wall stands.

However, whilst the Cumberland coast rigorously maintains some features, it does not, for example, continue the curtain wall. Nor do the milefortlets reflect the form or the function of the Wall's milecastles. Whilst the milecastles of the Wall painstakingly adhere to their plan, going as far as having gateways overlooking precipices, the same cannot be said of the milefortlets. The difference in anatomy between MF5 and other milefortlets serves to highlight this, the tower seemingly placed to provide both extra visibility over the Moricambe estuary and, importantly, extra visual prominence. Similar variance can be seen in their non-regular orientation and variety of gateways in terms of size and location within the structure. This demonstrates a contrast between the coast and Wall and a variance within the sample group itself. Above all else, this variability seems to be made in relation to highly localised phenomena, evidenced by the placement of MF5's tower to overlook Moricambe.

The reason for this becomes clear when the ditches are considered. Again, these appear to be functionally different when compared to the Wall's linear features. Interestingly, they do not provide any great impediment to foot traffic as their depth rarely exceeds 0.8m. On the Wall, the curtain means that all traffic would have to be focussed through either the milecastles or the forts. This is why the milecastles often ignore local conditions, best seen with MC35's cliff-top placement, or MC42's awkward location. This was not, however, an option on the Cumberland coast, thus local variation is a key factor in the form of the milefortlets. The role of the milefortlets is emphasised by both MF21, with its prominent seaward tower contrasting with the smaller landward version, and the ditches. Seemingly, these serve little practical purpose, however, symbolically they emphasise the Roman control of the landscape and accentuate the ritual nature of boundary crossing.[55] That they serve little practical purpose is unimportant, as this is congruent with the Wall. Due to a lack of curtain, the installations need to be organised differently.

The purpose of the Cumberland coastal structures is revealed by studying the relation between the Wall and coast. The Wall's symbolic power is intrinsically connected to its use, if there were an easy way of circumventing this, then much of the symbolic power would be lost. The differences in form all relate to responding to local variables. In essence, they are placed functionally to stop people moving and show the futility of circumventing the Wall; and symbolically, to highlight Roman control of the landscape and discrepant power. Thus, on the western coast the Cumberland installations stop circumvention of the Wall occurring. That a similar arrangement is not present on the east coast is due to the physical geography, with territory north of the Solway Firth providing an

[55] Discussed in Chp.3.

opportunity for sea travel that is not present in the east. Indeed, the Solway is fordable and Edward I died at Burgh-by-Sands planning an invasion of Scotland across the Firth.[56] When combined with the changing topography of the Cumberland coast[57] it may well be the case that Solway Firth, and the coast in general, was easier to cross in Roman times, a point reinforced by MF5's maritime visual prominence. This is not to say that circumvention of the line was not a worry in the east, the Wallsend extension proves otherwise, but rather installations like those on the Cumberland coast would not be required.

Consequently, there is the ironic conclusion that the theories of purpose for the Cumberland coast discussed previously, and dating back to Alexander Gordon's quotation which heralds this chapter, are correct in that the structures' primary goal was to prevent uncontrolled movement. However, given the Wall's symbolic purpose, this is not because the coast is a mere continuation of the Wall rather it is exactly because there are so many differences. The Wall's rigidity renders it a poor substitute for installations which can take account of local factors. The Cumberland coastal structures are just this, and their more functional role can be seen in the manner they diverge in several key ways from the Wall. Their role in preventing the avoidance of the Wall neatly demonstrates the importance of *praxis*, the physical use of the structures, upon which the symbolic power of the Wall ultimately depends.

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[56] Woolliscroft, 2001, 102.

[57] The Grune, south of Moricambe, is particularly open to change. The shifting sea level and erosion have claimed various Roman installations. Bellhouse, 1989, 36-7.

VIII | The Outpost Forts

No army can operate effectively without intelligence. But the garrison could not obtain useful information by standing on Hadrian's Wall, peering through the Scotch mist.

MANN, 1990, 53.

§ 8.1 | Introduction

Traditionally, the Outpost forts comprise a group of sites to the immediate north of Hadrian's Wall, with Birrens, Netherby and Bewcastle in the west, supplemented by Risingham and High Rochester in the east. The locations of these forts and their relationship to the roads and the Wall are shown on Figure 8.1. Functional interpretations of the Wall conceive the Outpost forts as a key component of the whole system. With the Wall interpreted as a divisive barrier, intelligence gathering is an important role which is applied to the five Outpost forts. This interpretation views the Outpost forts solely through the lens of the Wall. Previous chapters have considered a different role for the Wall, this chapter examines the ramifications of this reassessment for the Outpost forts: are they still part of the 'Wall system'? In answering this question historiographical traditions and the chronological development of the sites must be considered. The quantitative approach allows comparison between sites traditionally accepted as part of the overarching Wall-system, and independent Roman military structures. By divorcing these forts from their reliance and dependence on the Wall's function, their symbolism and purpose can be considered afresh.

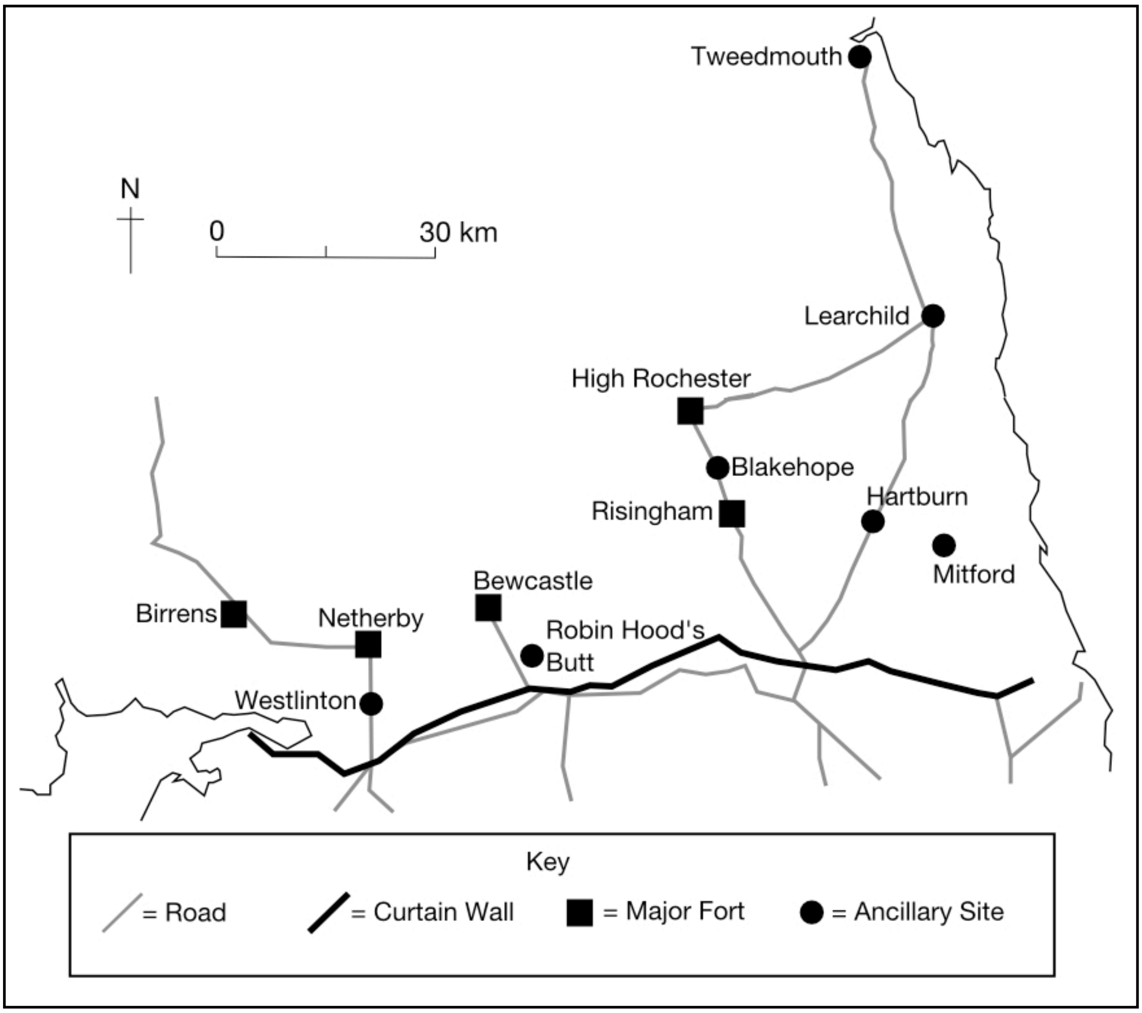

Fig. 8.1: Location of the Outpost forts, ancillary sites, Wall and major roads.

§ 8.2 | Schedule of Sites

There is debate to the extent of the Outpost group beyond the core five forts. Birley proposes a 'Wall-like' spread of sites as part of the Outpost network, this includes forts, fortlets and towers. The following schedule is suggested: 1 - Birrens; 2 - Netherby, 2a - Weslinton (fortlet?); 3 - Bewcastle, 3a - Robin Hood's Butt (signal tower); 4 - Risingham, 4a - Blakehope; 5 - High Rochester, 5a - Learchild, 5b - Tweedmouth (fortlet/small fort), 5c - Hartburn (fortlet), 5d - Mitford (fortlet).[1] These ancillary sites are included on Figure 8.1 alongside the traditional schedule of major fort sites.

The chronologies of the forts are highly variable and are listed on Table 8.1:

[1] Birley, 1961, 227.

Table 8.1					
Fort	Pre-Hadrianic	Hadrianic	Hadrianic Rebuild	Antonine	Antonine Rebuild
Bewcastle		✓			
Netherby	**?**	**?**			
Birrens	✓		✓		✓
Risingham				✓	✓
High Rochester	✓				✓

Table 8.1:Chronologies of the Outpost group's main forts.

These inconsistent chronologies question the concept of the Outpost forts as a discrete group. A connexion between the intended function of the Wall forts to the north would imply Hadrianic foundation, or pre-Hadrianic construction and co-option into the Wall system. As can be seen, only the western sites conform to this pattern, with only Bewcastle constructed contemporaneously with the Wall. High Rochester, although an Agricolan foundation, was abandoned in the Hadrianic era.[2] This highlights the weaknesses of monocausal functional explanations: the Wall's anatomy was the same across its entire length, military interpretations require structures like Bewcastle in the east to penetrate the epigraph's 'Scotch mist' and allow Hadrian's Wall to function.

Birley also includes the signal station Robin Hood's Butt, on Gillalees Beacon, which formed a putative signalling chain for Bewcastle.[3] Woolliscroft presumes more signal stations for the western forts, identifying the site of Barron's Pike specifically for Bewcastle,[4] shown on Figure 8.2, and several unnamed sites to allow lateral communication in the area.

[2] Hancke *et al.*, 2004, 35.
[3] Birley, 1961, 227, 233-5.
[4] Woolliscroft, 2001, 81-4.

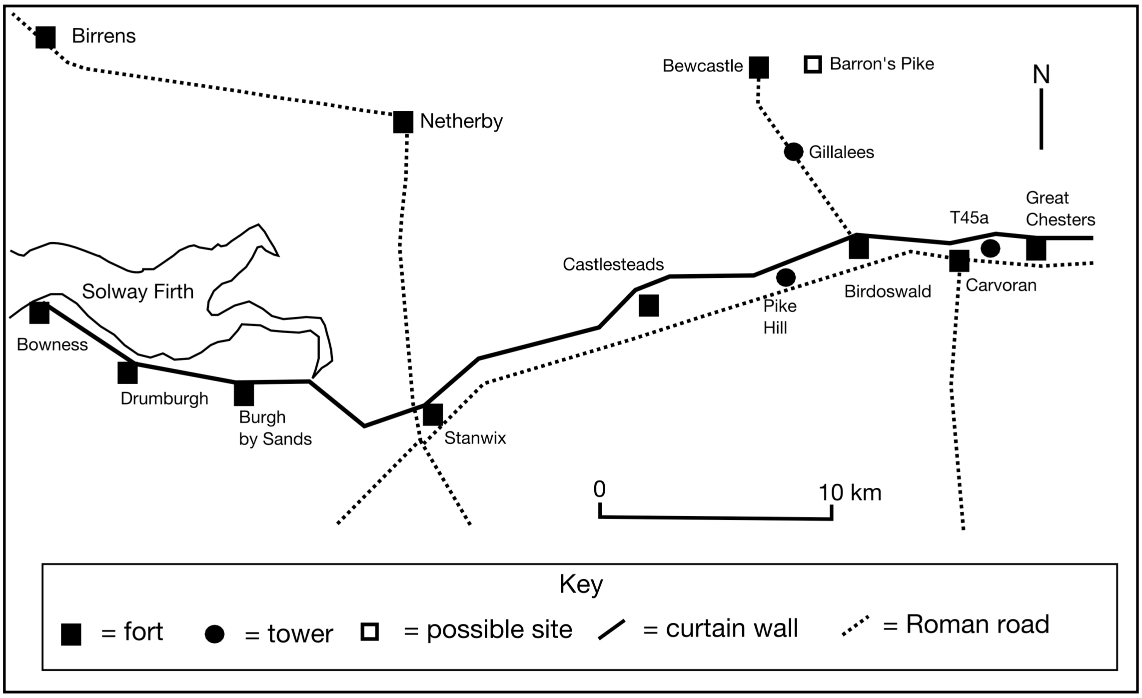

Fig. 8.2: Western Outpost forts with possible location of Barron's Pike signal tower.

In the east Woolliscroft suggested a signalling link to connect Risingham and High Rochester to the Wall. Chesterhope Common is the suggested site, shown on Figure 8.3.

Which of these many proposed sites, with differing chronologies and surviving archaeology, fit the remit of the study and were contemporary with the Wall?[5] Many of the tower sites remain to be identified or possess inconclusive archaeology.[6] Consequently, Robin Hood's Butt, despite not revealing any dating material, is included due to its conclusive archaeology and close association with Bewcastle.[7] Netherby (2), Weslinton (2a), Tweedmouth (5b), Hartburn (5c) and Mitford (5d) cannot be included due to a lack of surviving material or excavation.[8] Westlinton is not quantified as it remains unidentified, with only Stukeley's 18th century account of the site, rather than any archaeological remains, as evidence for the structure.[9] Learchild is quantified due to its early-2nd century

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[5] For chronological limits of the study see §1.2. Birley's numeric designations are included in brackets.

[6] Woolliscroft, 2001, 86-8.

[7] Woolliscroft, 2001, 80-1.

[8] For Tweedmouth, Hartburn and Mitford see St. Joseph, 1951, 56; for Westlinton and Netherby see Birley, 1953, 11, 32-3, respectively.

[9] Stukely, 1776, 57-8. Birley, 1953, 11, identifies the crossing of the Roman road with the River Lyne as the potential site, though he downgrades Stukeley's 'fort' to a 'fortlet' in his account.

evidence of habitation,[10] its multiple occupation phases mean that construction during the Wall's establishment is likely. Of the main fort sites, the Agricolan High Rochester is not included as it shows no evidence of Hadrianic occupation.[11] The sites which conform chronologically and survive sufficiently to be quantified are: Bewcastle, Birrens, Learchild and Robin Hood's Butt. Some exceptions are made for the purpose of discussion,[12] though these will not be included in projections for the cost of the Outposts.

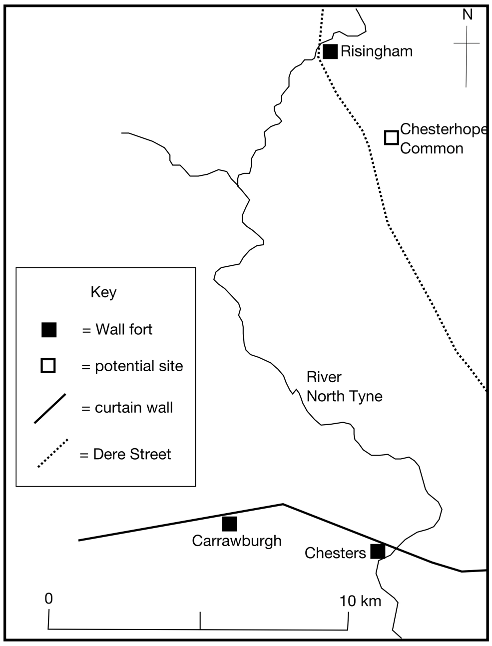

Fig. 8.3: Potential signal tower site on Chesterhope Common.

§ 8.3 | Traditional Approaches

That the forts are considered a functional part of the Wall system is intimately connected to the Wall's interpretation. This is as a divisive, defensive line which owes more to modern assumptions than to the Roman context.[13] Consequently, the Outpost forts reflect the modern perception of linear defence. Lord Pelham, in 1911, seeing the Wall as a military barrier, noted that the installations to the north served a vital combat function:[14]

> The outlying posts not infrequently found beyond the frontier may in some cases have been intended to keep order in this cleared border-land. But these posts also served the purpose of guarding and keeping open the 'lines of attack', the roads, that is, along with an expeditionary force would advance when sent to chastise a marauding tribe or quell a disturbance. Both these purposes may have been served in

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[10] Birley, 1961, 244.
[11] Hancke *et al.*, 2004, 35.
[12] Risingham and Blackhope in §8.5.
[13] See §2.4-5 & §3.4.
[14] Pelham, 1911, 172.

> North Britain by such posts as those of Birrens, Bewcastle, and High Rochester.

Importantly, this function is seen in light of the Wall's. Hadrian's Wall, as a defensive barrier, needed a method to be able to project its force northwards. According to Pelham this is supplied by the Outpost forts. Over 40 years later, Birley used the same reasoning:[15]

> '[Netherby, Birrens and Bewcastle] provide a chain of outposts a few miles north of the Wall in its western sector, where it can be shown that the military problems of the new frontier must have been most acute - witness the planting of an *ala milliaria* at Stanwix'.

Here the function of the Wall and that of the Outpost forts are intertwined. However, as modern perceptions of a military force have changed, so too has the role ascribed to the Outpost forts. Donaldson correctly stressed that the modern military is heavily reliant on threat perception.[16] This is subsequently retrojected back to the Roman era, and specifically to the milecastles of Hadrian's Wall:[17]

> It is certainly true that patrolling is an essential activity for the security of frontier areas, but active patrolling is extremely manpower intensive, and to maintain reasonable level of activity on a permanent basis would have required more men than the milecastles were capable of accommodating. My belief is that in the original plan limited reconnaissance patrols and occasional fighting patrols were envisaged to gather intelligence and dissuade potential reivers, but large-scale patrolling would only have taken place during a major alert when the forward line was reinforced.

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[15] Birley, 1953, 32-3.
[16] Donaldson, 1988, 125-6, 135.
[17] Donaldson, 1988, 134-5.

Despite the pre-existence of Birrens and possibly Netherby, as well as the construction of Bewcastle, Donaldson does not assign threat perception to these forts upon the Wall's completion. This is important, as it separates the Outpost forts from being viewed solely through the lens of the Wall. Mann's 1990 refutation of Donaldson's theory, however, places the Outpost forts back into Pelham's intelligence-gathering fold. Whilst agreeing in principle with the intelligence function of the milecastles, Mann suggests a shift to specialised scouting which can be seen in their stationing at Netherby, High Rochester and the newly founded Risingham.[18] Breeze, however, suggested the western Outpost forts at the time of Hadrian provided 'advance warning of attack', as well as protection for those north of the Wall.[19] Importantly, because Birrens and possibly Netherby antedate the Wall this would have to represent a change in their function due to the Wall's completion.

Woolliscroft states that 'the intelligence screen for Hadrian's Wall was presumably based in the Outpost forts'.[20] In order to facilitate this link between the Outpost forts and the Wall, in the case of Bewcastle, a chain of signal towers is presumed. As noted, with the exception of Robin Hood's Butt, these sites remain conjectural. Similar towers are proposed for the eastern group which are also unproven. These approaches all emphasise signalling and intelligence gathering, however, the group's variable chronology has shown the installations cannot be connected to the Wall across the entirety of its line. Yet a divisive military purpose is presumed for the Wall which cannot operate without such installations.[21] It is in this

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[18] Mann, 1990, 53.

[19] Breeze, 2006b, 97.

[20] Woolliscroft, 2001, 80.

[21] Woolliscroft, 2001, 80-1: 'the Stanegate was still a very open frontier, it could not have guaranteed the degree of preclusiveness that appears to have been demanded by the 2nd century Empire. In other words, it could not have provided the certainty that any threat to the province, however small, would be dealt with on or before the frontier line. The need to avoid all but a minimum of further dispersal, so as to retain the major groupings intact, was met by the construction of Hadrian's Wall […] The success of this otherwise flexible compromise would naturally have been heavily dependent on intelligence gathering.'

Gordian Knot of function, intention and systems that the core problem of both functional and mono-causal theories can be seen. The current site chronology shows that only the western section could have had the possibility of a signalling system upon the Wall's completion. Yet the Wall is designed anatomically identically across its length, therefore signalling could not have been the sole intended purpose of these structures.

§ 8.4 | Geography and Proximity

It is vital to consider the broader contexts of these installations. Firstly, the eastern forts of Risingham and High Rochester are located on Dere Street. Their function is usually attributed directly to their proximity to the Wall, yet these forts are related far more closely to the road. High Rochester is an excellent example: at the time of the Wall's construction the Agricolan fort had been abandoned, thus its purpose cannot be connected directly to that of the Wall. It was located *c.*30 km away from the nearest Wall-fort at Carrawburgh. To put this into perspective, in the west, Bewcastle is *c.*10 km from the nearest Wall-fort at Birdoswald; and Netherby has three Wall-forts, Burgh-by-Sands, Stanwix and Castlesteads, within 15 km. Clearly, in terms of completion date and proximity, High Rochester stands apart from the Wall. Both Tweedmouth and Learchild's association to the Wall can also be doubted on these same grounds. Consequently, the eastern forts occurring before or contemporary with the Wall are discounted from the group. Thus on geographic as well as chronological grounds their is reason to doubt the traditionally defined 'Outpost' group. Considering the Outposts not as installations merely serving the Wall, but as discrete structures in their own right is key to understanding their purpose in the pre- and post-Hadrianic landscape. What of the forts contemporary with the Wall, does the quantitative survey imply the use of the same structural vocabulary as employed on the Wall?

§ 8.5 | Quantitative Survey

As the above discussion has shown, many sites presumed to be Outposts can be called into question. Some sites discounted from the sample group are quantified to provide comparanda. Risingham, an Antonine-era fort, is quantified to allow comparison with the Wall as it is the only stone fort in the traditional Outpost group. Similarly, Blakehope, which pre-dates Hadrian's Wall,[22] is included in the quantitative results for forts for comparative purposes. These forts will not be included in any projections of total cost or work rate. As always, type I turf and timber structures are presumed, with type I towers assumed for Robin Hood's Butt.[23]

Firstly, the turf and timber forts: Bewcastle, Blakehope, Birrens, and Learchild are compared with Drumburgh, the only surviving example from the Wall. The results are shown on Table 8.2:

Table 8.2		
Fort	Work Rate	Cost
Bewcastle	127,896.15 person days	£18,920,593.12
Blakehope	103,682.48 person days	£15,283,564.97
Birrens	103,631.29 person days	£15,301,280.76
Learchild	61,505.08 person days	£9,128,831.65
Drumburgh	65,376.97 person days	£9,700,701.61

Table 8.2: Results for the turf and timber forts compared to Drumburgh.

Clearly, much of the group is far more labour intensive than Drumburgh and thus far more costly. The small sample group must be noted, though it is clear that the two 'main' forts, Bewcastle and Birrens, are significantly more labour intensive than Drumburgh. Indeed, Bewcastle, with its highly atypical shape, shown on Figure 8.4, is almost twice as demanding in work rate and cost.[24]

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22 Birley, 1961, 241-2.

23 See §4.3.

24 Bewcastle has an area of *c*.29,400m^2, behind Stanwix's 37,067.43m^2.

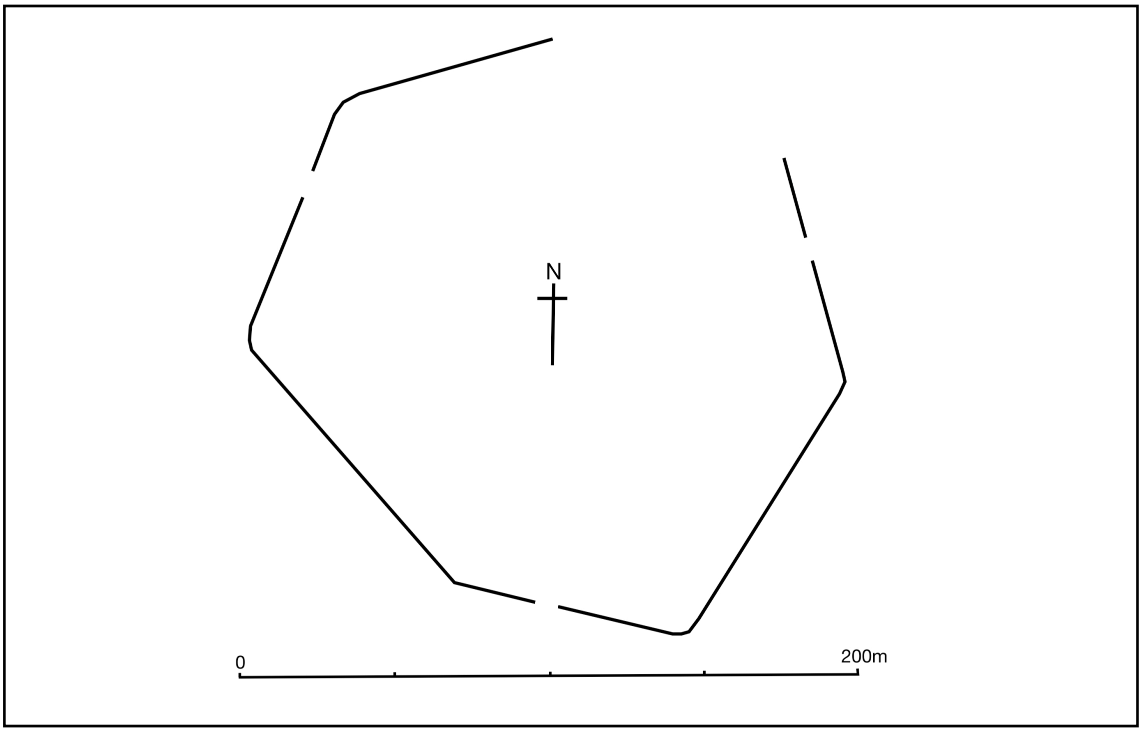

Fig.8.4: Bewcastle's atypical hexagonal shape.

Risingham, whilst not contemporary with the Wall provides comparandum with the average stone wall fort. The results are shown on Table 8.3:

Table 8.3		
Fort	Work Rate	Cost
Risingham	103,582.01 person days	£31,995,765.43
SW Average	112,431.11 person days	£32,474,776.36

Table 8.3: Results for Risingham compared to the stone Wall's average.

The signal tower of Robin Hood's Butt is compared with the turrets of Hadrian's Wall and the Cumberland coastal towers. Table 8.4 shows the results of their survey,[25] type I tapered structures are presumed:

[25] The turf wall and Cumberland coast are chosen for comparanda here as they are closer structurally to Robin Hood's Butt than the turrets of the stone wall, which recess into the curtain and thus have a higher structural volume, work rate and cost.

Table 8.4		
Structure	Work Rate	Cost
Robin Hood's Butt	865.86 person days	£242,079.47
TW Average	523.41 person days	£146,335.89
CC Average	538.02 person days	£159,564.12

Table 8.4: Comparison between Robin Hood's Butt, TW and CC average.

Clearly there is a difference in structural vocabulary, with Robin Hood's Butt exerting a far greater demand for in labour and cost.[26] Risingham can be seen to be broadly equivalent to the Wall-forts in labour and cost. This does not, however, confirm a function congruent with that of Hadrian's Wall as Risingham's Antonine inception is temporally far removed from the Wall.

As the schedule of sites shows, there are no structures like the Wall's milecastles or the coast's milefortlets. This can be interpreted as a difference in form and purpose between the Wall and its 'outposts'. The total cost of the Hadrianic structures is shown in Tables 8.5-6.

Table 8.5		
Structure	Work Rate	Cost
Birrens	103,631.29 person days	£15,301,280.76
Bewcastle	127,896.15 person days	£18,920,593.12
Learchild	61,505.08 person days	£9,128,831.65
Robin Hood's Butt	865.86 person days	£242,079.47
Total	293,898.38 person days	£43,592,785.00

Table 8.5: Quantitative results for Hadrianic structures.

With Netherby's lack of surviving anatomy, an average of Birrens and Bewcastle's results are used to proxy the structure's quantitative survey. This is shown on Table 8.6,

[26] Interestingly, a build team of one *contubernium* would require just over 100 days to complete a station the size of Robin Hood's Butt. This means that two installations could be finished per building season. As noted, Woolliscroft proposes a second link in the signalling chain at Barron's Pike. There is, then, enough time left in the building season for this to be made a reality. This is, of course, conjecture as no archaeological evidence has been located.

alongside the full estimated labour and cost:

Table 8.6		
Structure	Work Rate	Cost
Netherby (Avrg Used)	115,763.72 person days	£17,110,936.94
Known Total	293,898.38 person days	£43,592,785.00
Overall Total	409,662.10 person days	£60,703,721.94

Table 8.6: Total labour demand and cost, including Netherby projections.

The theoretical maximum number of workers on each site is shown on Table 8.7. This is calculated in line with the project methodology of having one person per 14m^2 on site, and shows the maximum number of people who could be physically accommodated on each site:[27]

Table 8.7		
Structure	Area	Max. Number of Persons
Birrens	24,200m^2	1,728.57
Bewcastle	29,400m^2	2,100.00
Learchild	3,574.91m^2	255.35

Table 8.7: Maximum number of persons who could realistically work on a fort site.

The Hadrianic-era building programme north of the Wall adds *c*. 400,000 person days to the overall labour demand, and an extra *c*.£60 million to the total cost.[28] According to the Wall's chronology,[29] the Outpost forts were commenced in A.D.123, or A.D. 124 at the latest, and completed by A.D.130, a minimum of six and a maximum of seven building seasons. Consequently, some 300 men would be required to complete the installations in the given time

[27] See §4.8.3. The other two thirds are related to members of the unit who would be engaged in off-site activities, e.g. supply; and those missing as most units appeared to be one-third under strength.

[28] Woolliscroft's putative extra signal stations at Barron's Pike and Chesterhope Common would not have caused any major added costs for the completion of the Hadrianic forts within this group. Indeed, another two or three signal stations commensurate in size with Robin Hood's Butt, which is notably larger than the turrets of the Wall, would add less than 1% to the total labour and fiscal costs.

[29] Breeze & Dobson, 2000, 86-7, Tab. 7.

period,[30] this could be provided by one *quingenary* unit operating at a standard two-thirds strength.[31] The forts are the most labour intensive and costly structures in the sample group. These could accommodate far more workers on-site than seem to have been used. This stresses the need for an holistic understanding of the Wall and its 'associated' systems in terms of their labour demands. The labour saved from taking such a comparatively long time to complete the Outposts frees people to work elsewhere. This is similar to the Cumberland coast[32] whereby its low labour demand allows many soldiers to be assigned to other building areas.

§ 8.6 | Conclusion: Outposts of Hadrian's Wall?

The variable chronologies of the Outpost fort group, and their broad lack of similarity to the structures of the Wall, raise two fundamental questions. Firstly, can these structures be said to form a coherent group; secondly, do they bear any relation to Hadrian's Wall? The former question is the most straightforward to answer. Whilst they are often connected to the Wall due to its functional requirements, their asynchronous chronological development, with some installations built *c*.100 years later, makes their inclusion as a discrete group improbable. Furthermore, the lack of archaeological evidence for many of the sites proposed by Birley makes an overarching 'system' difficult to discern and support.

Clearly, the traditional 'Outpost forts' should not be grouped as such; there is a case for breaking the group into smaller sub-categories. For example, the broad contemporaneity between the western forts and the Wall mean that they could form a discrete group of installations.[33] Such moves have ramifications for

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[30] Exact figure is 292 men for seven seasons, 342 to complete in six.

[31] The Tungrian strength report implies that under-strength units would be the norm.

[32] See §7.8.

[33] The number of installations on the western side of the Wall is often taken to imply that there was a greater military threat in this area. Considering the forts not as functional fighting machines, but rather as key players in changing the landscape, implies that, during the Hadrianic period, Rome was highly interested in changing, subverting and co-opting the landscape in the west of the Wall area.

understanding the Wall as a whole. Woolliscroft proposes signalling as the raison d'être of the Wall, responsible for the locations and placement of many installations.[34] Given the Wall's anatomical uniformity, and the lack of an intelligence screen in the east, signalling as the singular explanatory cause for the Wall's form cannot be maintained. This highlights the key flaw in monocausal theories for understanding the function the Wall. This is not to say that signalling did not develop to be an important component of the Wall. This is a possibility in the east with the reoccupation of High Rochester,[35] the foundation of Risingham and the conjectural signalling site on Chesterhope Common.[36] Similarly, the name of Netherby, given as *Castra Exploratorum* in the 3rd century Antonine Itinerary, reinforces the rise in emphasis and specialisation of this role. The presence of the *numeri exploratorum Bremesiensium*, in High Rochester in the mid-3rd century is further reinforcement.[37] However, due to the Antonine chronology of these sites and sources mean that they cannot be connected to the original function and design of the Wall.

This leads to the broader question of these forts' association with the Wall. Firstly, it is important to understand that the root of the Outposts' connexion to the Wall, as the intelligence screen, is an extension of the defensive and functional interpretations of the Wall. This line-in-the-sand required intelligence gathering in order to be effective. Such interpretations are best emphasised by Luttwak's definition of a 'scientific frontier'[38] which demonstrates that all threats are to be met beyond the 'boundary' of empire.[39] This would have been impossible without some form of intelligence gathering beyond the 'border'. However, given that this function for the Wall

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[34] Woolliscroft, 2001, 63-78..

[35] Hancke *et al*., 2004, 35. High Rochester appears to have been re-occupied in the mid-1st century and abandoned after the withdrawal from the Antonine Wall. It was reoccupied again at the dawn of the 3rd century.

[36] Wolliscroft, 2001, 82, 86-8.

[37] Netherby: Breeze, 2006b, 99; High Rochester: Hancke *et al*., 2004, 36.

[38] Discussed at length, §2.4.

[39] See Fig. 2.4.

has been exploded, where does this leave the discrete group of Hadrianic-era forts to the north of the Wall?

Without the Wall's need for intelligence gathering, the forts must have served a different purpose. As noted, they are far more closely connected to the road system than to Hadrian's Wall. In which case, it would appear that these structures are normal forts along a line of a road in a manner seen right throughout the Roman empire. However, it is important to note that this still complements the symbolic purpose of the Wall, and may well emphasise and enhance the structure's message. Roads are not simply a functional abstraction to allow the military to move around quickly,[40] but are 'arenas of social power'[41] in much the same way as the landscape within which Hadrian's Wall is located. This landscape is a reflexive, socially mediated space.[42]

With this in mind, it is possible to see that both roads and forts contribute to the underlying symbolic power of the Wall. The roads directed movement towards the Wall, in much the same way that the Cumberland coast acts to support the Wall by preventing circumvention of the line.[43] However, this goes further than simply directing traffic. The use of a road itself is an act of praxis that was based upon a military construct. Roads were planned and erected across the landscape by Rome and highlighted the co-option of key social spaces by Rome. This was entirely congruent with those same aspects on the Wall, with one supporting the other. Indeed, the importance of roads and road building in this era is highlighted by Hadrian's widespread construction of *mansiones* and roadside settlements in Roman Britain, financed from the imperial fisc.[44] Furthermore, Hadrian's initiation of the first milestone survey of the

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[40] Witcher, 1998, 69; contra Luttwak, 1976, 2, 19, who sees roads and camps as being 'in order to avoid the unpredictable risk of rapid maneuver.'

[41] Chapman *et al*., 1996, 290-1. This is in reference to the roads and *centuriation* of land in Dalmatia.

[42] See §3.3.

[43] See §7.9.

[44] Black, 1995, 9, 32.

province[45] reinforces the connexion between the emperor, the state, and the space which has been co-opted. This was highly visible to all those who used the roads.

Consequently, use of the roads which ran to Hadrian's Wall was a concession to the auspices of Roman power.[46] Perhaps the most interesting outcome of such a process is the multiple viewpoints and interpretations. Whilst this gave Rome substantial control over everyday aspects within the environment, the acceptance of Roman power is tacit rather than explicit. There were divergent responses available for those who use the road network, the use of material culture, however was the most important aspect to the Romans.[47] This leaves open the possibility that those using the road could well be doing so without acceptance of Roman hegemony.[48] This may mirror the process seen in Roman Achaea, where the widespread use of Roman structures takes place without the population ceasing to consider itself Greek.[49] Thus, the power of the roads lie in participation, not acceptance. It is a combination of this subtlety, hand-in-hand with immense overstatement, that supports Roman appropriation of the landscape.

Roads, whilst a blatant tool for the reordering of the landscape, also had a subtle power. One route could be emphasised over another, resulting in certain settlements benefitting over others. Thus, roads became a political and economic weapon of Rome, all of which were served by milestones legitimating the state and the emperor. This is underscored by the use of Latin, further emphasising the Roman nature of the road and thus the landscape. These subtle features, promoted by participation, were supported by monumental statements of power represented by the effort of the roads'

[45] Sedgley, 1975, 2; Black, 1995, 45.
[46] Witcher, 1998, 67.
[47] Woolf, 1994, 130.
[48] Witcher, 1998, 64.
[49] Woolf, 1994, *passim*.

construction and upkeep, their comparative straightness[50] and the use of large quantities of stone. These factors highlighted the difference between the new Roman space and that which came before.

The roads themselves, however, are static objects and their intended symbolic power would fall silent, or be easily subverted and changed, were they not acted upon. It was the presence of installations like the Outpost forts which negated this threat of muted, empty-rhetoric. First, the act of construction itself was an immensely powerful symbol of Rome and its military.[51] The materials used for the roads, the stone, underlines this. Its exploitation, movement and transportation relates to the broader Roman world in an esoteric and literal manner: the roads connect with one another, eventually, back to the *Caput Mundi*. The upkeep and repair of roads by the units serves to maintain the power of their technical skill, the mention of such acts in milestones concretise this even when no such action is taking place. Similarly the mere presence of the soldiery acts to reify Roman power and legitimacy over space in the same way as the presence of soldiery on the Wall refers to Roman military victories. This is a key part of the power imbalance and latent threat and is reinforced by the display of technical skill and the institutions of Rome. All of these facets are rendered real on a daily basis by those using the roads.

In this sense, the forts are indeed outposts of Hadrian's Wall as they complement the overall symbolic message of the Wall and thus play an important role in contributing towards the Wall's appropriation of space. This is not to deny them functional roles in military control of the areas north of the Wall, or even involvement in intelligence gathering. It is to stress that the symbolic, non-quantifiable aspects

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[50] Itself a feature perhaps used to emphasise Rome's domination over nature itself. By not following convenient topographic features they stressed their dominance, in a similar way to great military victories being celebrated because of their difficulty. The amount of effort increased the symbolic power of the result. Witcher, 1998, 67; Mattern, 1999, 208.

[51] See §3.4.

of the roads, the forts and the soldiery are of equal importance to their 'practical' function. It may well be the case that there is no such divide in the Roman-era between the abstract and the functional, as can be seen in other areas of Roman statecraft.[52]

The severance of the traditionally defined 'Outpost forts' from the Wall's overly functional interpretations highlights their role within the landscape. Consequently, it is possible to see that emphasising one facet of the many aspects of Roman military operations, in this case intelligence gathering, does not satisfactorily explain the presence of these forts. It is in understanding the multiple divergent roles the military play and represent in the ancient world, as well as their discrepant reception, that the influence of Rome on the landscape, and thus the relationship between these forts and the Wall, can be seen. The chain of signifiers which link the Wall, the roads, the soldiery and the forts to one another and Rome can be seen in the Outposts and in the landscape itself. Their connexion towards conquest, domination and appropriation can be seen in the many aspects of their presence, from the weapons and presence of soldiers through to the materials used to construct roads and forts. This can even be seen in abstraction through the use of milestones, names and language. The roads and forts which lie to the north of the Wall are thus far more than a functional adjunct of a defensive line, but are deeply involved in the negotiation and perpetuation of discrepant power relations on a day-to-day basis. Such dialogue allows Rome to create, subvert and dominate landscapes and provinces.

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[52] See Mattern, 1999.

IX | Environment, Economy and Supply

'For armies are more often destroyed by starvation than battle, and hunger is more savage than the sword.'

VEGETIUS, *MIL.* III.3

§ 9.1 | Introduction

This chapter considers the supply of the Roman personnel responsible for the construction of the Wall. This is to answer the fundamental questions: how were the soldiers supplied, how many people were needed and what effect did this have on the landscape? This impact will consider the scale of supply as an extension of the symbolism of building; representing control over surplus labour and resources. The process of supply exists in the landscape as an ongoing process, making this a powerful demonstration of *maiestas* available to all who use the Hadrian's Wall area. Consequently, many factors need to be addressed, including the environment around Hadrian's Wall and the more general context of supply in the Roman world. The primary focus of this chapter is food; this is not to underplay the myriad of other requirements the army had[1] but is a reflexion of the literal and metaphorical weight of importance placed on food supply. Food, fodder and firewood alone accounted for some 90% of supply weight that an ancient army required[2] and its importance was well-understood by ancient authors including Vegetius.[3] As will become

[1] Including metal and leather, see §9.3.1 and Breeze, 1984.

[2] Roth, 1999, 2.

[3] Supra, Veg., *Mil.*, III.3. Saepius enim penuria quam pugna consumit exercitum, et ferro saevior fames est.

clear, other factors, such as the number and supply of the army's animals, are of vital importance.

Whilst this study reflects basic calorific needs, all armies need food in order to survive, specific attention is paid to the wider cultural impact of the type of supply utilised. This is another aspect of an interpretation of the Roman military as 'an essential instrument for the survival of the Empire'[4] in terms of culture rather than solely conquest.[5] Indeed, use of terms like 'occupied regions'[6] shows that too often the Roman army is considered in a modern context that places little emphasis on its role in others 'becoming Roman'.

Naturally, this is not the first attempt at quantification, though the Wall itself poses some unique questions about supply in the Roman world. The works of Peddie[7] and Engels[8] are particularly informative in this area; importantly both of these works concentrate on an army in the field actively campaigning against an operational foe. This was not the case with Hadrian's Wall, and it is the question of supply for a static body of soldiery that is key.[9] Above all, the methods of

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[4] Carreras Monfort, 2002, 71.

[5] Contra Kerr, 1989, 442: 'Above all, we should remember that military security was Rome's main concern on her northern frontiers, where there was a constant strategic threat of varying intensity'; Higham, 1991, 94: 'The garrisons were present to guarantee the frontier, police adjacent areas and to oversee the passivity of the provincials'; Kolb, 2002a, 161: '[The Roman army's functions] were primarily those of defence and the guarantee of peace and order throughout the empire'; Funari, 2002, 239: 'The troops under arms were intended to suppress internal dissent more than external threats.'

[6] Remesel Rodríguez, 2002, 80. This particular excerpt considers the avenues of supply open to the Roman military. The entire goal of the military, as has been seen elsewhere, is not to exploit 'occupied land', rather it is to make it as 'Roman', with the byproduct of productivity, as possible. Tac. *Hist*. I.64, provides such an example of the supply from Gallic communities for Vitellius' forces in A.D.68: 'Lugdunum did gladly what the Aedui had done from fear', Quod Aedui formidine Lugdunenses gaudio fecere. The end goal is the same, securing supply, however the military process ends with such willing participation in the idea of Rome. See also Agricola ending routine plundering in Britain due to the increasing level of 'Romanisation' in the province, Tac. *Agr*. 19.4, 'Demands for grain and tribute he made less burdensome by equalising the burdens', Frumenti et tributorum exactionem aequalitate munerum mollire.

[7] Peddie, 1987.

[8] Engels, 1978.

[9] Roth, 1999, 3: 'Researching military supply should not merely investigate individual circumstances or question of particular details, but "rather […] should be a picture of the supply situation under normal […] circumstances."'

supply available to those constructing the Wall, and understanding the impact of the mechanisms in place to achieve this, are the goal of this chapter. This question is all the more pertinent given the prevailing opinion that 'the *limes* of Britain or Germany could not supply enough corn for the army stationed there […]'[10] where 'self sufficiency from [the land] alone would have been impossible.'[11] Modern understandings of the role of the military obfuscate our interpretations of the Roman army. Just as Roth discusses the modern and ancient comprehension of logistics[12] and Funari problematises the modern capitalist understanding of the word 'supply',[13] it is a realignment of what should be expected from military supply and 'self sufficiency' that will provide insight into both the type and impact of the Wall's supply.

§ 9.2 | Similar Studies

Peddie's *Invasion: The Roman Conquest of Britain* and Engels' *Alexander the Great and the Logistics of the Macedonian Army* share many similarities. First and foremost, they deal with active campaigning armies. They also share similar methodologies for tackling the issue of supply: seeking to estimate the number and rate of resource consumption of both soldiers and animals. Both consider factors specific to their campaigns: Peddie discussed the difficulties facing Caesar in arranging supply across the English Channel[14] and Engels considered the difficulty of supply whilst moving through unfriendly territory.[15]

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[10] Carreras Monfort, 2002, 73.

[11] Whittaker, 2002, 224, 225. Also note Higham, 1989, 1991, *passim*. '[Northern Britain was] economically retarded and socially backward.'

[12] Roth, 1999, 3. Here 'logistics' is shorn from its modern 'military science' connotations and is defined simply as the means by which food, firewood and fodder were delivered to the soldiery.

[13] Funari, 2002, 237-8.

[14] Peddie, 1987, 7-10.

[15] Engels, 1978, 2.

Interestingly, the experience of pre-mechanised western armies are taken into account in both studies.[16] This is not just in the area of rates of consumption and the requirements of soldiery, derived from the US Army Quartermaster Corps and the Veterinary Handbook of 1908,[17] but also for the perception of the landscape. Engels discussed the 19th and early-20th century military intelligence gathered on the area of the Macedonian march through Iran, Afghanistan and neighbouring areas,[18] stating:[19]

> '[this information] consisted of the same type of intelligence needed by Alexander: climatic conditions, how long the mountain passes remain blocked in winter, harvest dates (which depended on climate), the easiest roads, which routes are best provided with water and forage, the location of large areas of cultivatable land, and the logistic problems of moving through the region.'

Quite apart from the difficulties created by two thousand years of changes in the landscape, this list shows that Engels' approach is a firmly functional, objective view of resources to be exploited, catalogued and accounted; not the subjective socially mediated canvas discussed in modern landscape archaeology.[20]

Aside from these methodological issues, the fact that Hadrian's Wall was not constructed by a campaigning army questions the direct relevance of Engels' and Peddie's works. Whilst the number of soldiers building the Wall was as numerous as an army, there are vital differences between a static and campaigning force. The units that built the Wall were part of a pre-existing province, with a

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16 It should be noted that Peddie is the most willing to employ ancient sources in his analysis. Peddie, 1987, 29-30, 32, 38. Ammianus Marcellinus, Plautius and Polybius are cited here, along with papyrological evidence.

17 Engels, 1978, 123-9; Peddie, 1987, 32.

18 Engels uses the term 'Turkestan', which now covers the states of Kazakhstan, Uzbekistan, Turkmenistan, Kyrgyzstan and Tajikistan.

19 Engels, 1978, 4.

20 See §3.3.

developed infrastructure, they were not in enemy territory. This makes some of the problems of supply highlighted in Engels' and Peddie's work redundant, the limits on how far a pack-animal can move foodstuffs,[21] and Caesar's soldiery relying on forage,[22] are both negated by the road system and the *cursus publicus*.

As with supply in general, it is the manifest importance of roads that results in their low profile. Their value is taken for granted.[23] Whilst this value is often presumed to be functional, there are symbolic dimensions to the seemingly mundane. The road system itself has been described as being 'a military road system' entitling 'soldiers and officials to transport supplies at a cheap rate',[24] undoubtedly the roads played a major role in aiding supply. Furthermore, such connexions between the soldiers, the roads and their means of supply were highlighted by milestones which connected the emperor to the symbolic whole. The first known milestone survey in Britain was initiated by Hadrian, dating as early as A.D.119, before the commencement of the Wall.[25] Such regular reminders of imperial authority legitimated the emperor, his building programmes and connected him to the *praxis* of using the roads.[26] The connexion of supplies to the roads further symbolically strengthened the network, connoting the riches of the empire and the inclusion of the landscape in the wider Roman world. Indeed, the network attached to Hadrian's Wall for supply is of a type of which Alexander, in Engels' study, could only have dreamt.[27]

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[21] Engels, 1978, 128-9.

[22] Peddie, 1987, 7.

[23] As with supply in general, it is the manifest importance of roads that results in their low profile. Their value is taken for granted. Kissel, 2002, 158.

[24] Black, 1995, 1, 7; Kolb, 2002a, 164; *id*., 2002b, 68; Jongman, 2002, 45.

[25] Sedgley, 1975, 2; Black, 1995, 45; RIB 2244, 2265, 2272 for examples. This was part of a far larger programme of work on British infrastructure by Hadrian, encompassing *mansiones*, the *cursus publicus* and state financing. Black, 1995, 45.

[26] Kissell, 2002, 147-8. *Praxis,* and its benefits, is discussed in Chp.3 chapter. Further *praxis* gains can be seen in their expensive repair, Kissel, 2002, 131-2.

[27] One type of supply, be it for a sedentary force or campaigning soldiers, was not more or less sophisticated. Rather, the different situations had variable requirements. These different needs can be archaeologically visible, so their presence or absence on Hadrian's Wall helps indicate its type of supply. Meikle, 2002, 240-1.

As shown by Caesar's plans, soldiers on campaign could only forage to supply themselves.[28] This necessitated a different supply mechanism for a sedentary force, foraging was no guarantee of sufficiency as local resources would be swiftly exhausted.[29] Furthermore, the sheer number and concentration of soldiers along the line of the Wall would present a different challenge again from supplying widely distributed stationary units.[30] This challenge had to be met by a magistrate with cross-provincial jurisdiction in order to marshall and move such volumes of resources. Throughout various periods this role fell to different persons and organisations: the Senate, during the late Republic, could have fulfilled this role; the emperor, during the principate, would have been the natural successor.[31] However, by the time of Hadrian, a different structure had developed involving a magistrate charged with the organisation of supply for a particular campaign. Importantly, these officials were not part of the standard organisation of the empire and the roles were allocated to specific persons, both efficient and trustworthy, in preparation of large-scale campaigns.[32]

Whilst such an administrative role may well be expected of a continent-straddling empire, this position is not attested in all eras. Both Domitian and Trajan have officials who performed such roles, as did Marcus Aurelius and many emperors thereafter, however, there appears to be a hiatus under Hadrian and Antoninus Pius,[33] clearly due in part to Hadrian's lack of major military campaigns.[34] The lack of such positions under Hadrian, and the lack of evidence for a 'Wall commander' that could organise the garrison as a

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[28] Peddie, 1987, 7, 10.

[29] Roth, 1999, 171; Fulford, 2000, 42.

[30] Roth, 1999, 167.

[31] Erdkamp, 2002, 53.

[32] Remesal Rodríguez, 2002, 87; Erdkamp, 2002, 52, 54-5. Interestingly the amount of trust may well have been an important consideration. The *dispensator* of Nero's Armenian campaign managed to embezzle 13,000,000 sesterces, the equivalent of thirteen senatorial fortunes, which may well have only been a fraction of the overall cost of the campaign. Roth, 1999, 238; Mattingly, 2007, 222.

[33] Erdkamp, 2002, 54-5.

[34] Hadrian chose to patronise the army in a different fashion, emphasising discipline and making tours of the units stationed throughout the empire. Mattern, 1999, 206.

discrete unit[35] further emphasises that the Wall itself should not be viewed as similar to a campaigning army in its supply. This demonstrates firstly that the supply of Hadrian's Wall would have been considered part of the 'normal' supply mechanisms; and secondly that the idea of a discrete army manning the frontier is a largely modern construct.

Archaeological evidence further underlines this assertion. As noted, it was the responsibility of a specific official to concentrate the correct supply in the correct place for a campaigning army. The terms *stativa* and, less commonly, *sedes belli* are used for 'military supply bases';[36] these would be in secure locations with excellent communication links. They were often connected to improvements to port and storage facilities.[37] If the Wall's units were a discrete frontier defence force there would be evidence for such a structure: there is, however, none. This situation is perhaps best demonstrated by South Shields. Under Septimius Severus[38] the number of *horrea* in the fort rose from one double granary[39] to 13, with seven more added *c*.A.D.220-35 eventually giving two-thirds of the fort's area over to *horrea*.[40] South Shields conforms to what would be expected of a *stativa*, it has good access to water-borne supply lines[41] and, as noted, can store a vast amount of supplies. Consequently, it may have been used for Severus' campaigns in

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[35] Breeze, 2006b, 111. Erdkamp, 2002, 52: 'It appears that such special officials were the exception rather than the rule. They cannot have been the ones normally responsible for the corn supply of the Roman armies'.

[36] Roth, 1999, 169.

[37] Roth, 1999, 171, 173; Remesal Rodríguez, 2002, 86-7. Roth notes that, according to Polybius, New Carthage's port is improved dramatically in order to serve the Carthaginian army during the Second Punic War: 'an artificial communication had been opened between the lagoon and the neighbouring sea for the convenience of shipping, and over the channel thus cut the tongue of land that separates lagoon and sea a bridge has been built for the passage of beast of burden and carts bringing in supplies'. Polyb. 10.10.12-3.

[38] As noted above, the organisational magistracy for campaign supply can be attested in Severus' reign.

[39] Richman, 1971, 226, Fig.40. Enough to supply the unit for a year, discussed infra.

[40] Rickman, 1971, 290; Bidwell, 1997, 87. For plan see Bidwell, 1997, 88, Fig.58.

[41] Roth, 1999, 169.

northern Britain from 206-211.[42] Importantly, Severus needed to create such a base as none already existed.

This evidence demonstrates that there was not a 'one-size-fits-all' solution to supply in the Roman world. Different statuses of units, be they on campaign, wintered or in permanent garrison, would be met with different types of supply.[43] Clearly, given the aforementioned limits on a campaigning army and the means and mechanisms designed to deal with this, total self-sufficiency and divorce from central government was not the goal of the Roman military's supply. Different types of supply, with different emphases, would meet different units depending on their specific needs.

Given the lack of a magistrate specific to the supply of the Wall's construction, or, indeed, a 'command structure',[44] and the lack of archaeological evidence for a dedicated supply base, it is hard to accept Roth's claim that the 'frontiers of the empire were more or less continually in a state of war'[45] as the most important signs of this state were not present. Consequently, the Wall's supply must be considered in light of the Roman world at large, that is, 'under normal circumstances'.[46]

§ 9.3 | Quantification

Methodologically there is little difference in determining the exact demands for a body of soldiers when on active campaign or sedentary. As a consequence, some of the methodology used by Peddie and Engels is applicable to the soldiers who were building the Wall. The first step in the process is understanding with what the soldiers were supplied, followed by the number of soldiers, thus providing a total demand for each item of food. Finally, the ability of

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[42] Roth, 1999, 177. van der Veen, 1992, 155 connects the construction of 22 granaries to this campaign.
[43] Manning, 1975, 115; Erdkamp, 2002, 49, 60.
[44] Breeze, 2006b, 111. See §2.4.
[45] Roth, 1999, 167.
[46] Roth, 1999, 3.

the surrounding land to support the food demands of the soldiery needs to be assessed.

In terms of equipment, the Roman soldier required a bewildering array of items. Armour (greaves, mail shirt, *lorica segmentata* or scale shirt), clothing (skirt, tunics, knee breaches, underclothes, shoes, socks and cloaks), belts, swords, daggers, shields, shield-covers, spears and animal skins. Different units had special requirements of bows, arrows, saddles, bridles, bits, buckles and straps.[47] This is, undoubtedly, a formidable list, especially when multiplied by several thousand in the supply of groups of units. However, the supply of such items will not be considered here for a number of reasons. Firstly, these items did not form the bulk of supply.[48] Widespread issue of such items would only occur during the raising of a new unit, the addition of heavy numbers of new soldiers to an existing unit, or after a battle or campaign. Such specific events are not part of the 'supply situation under normal circumstances'.[49] The large number of *immunes* attested in the epigraphic record show that each unit had skilled staff at its disposal able to effect repairs and manufacture many of the items listed above.[50] This is the most likely source of maintenance of a unit's equipment under normal circumstances. These normal circumstances are dependent on supply, too great a labour burden would affect numbers who could work on construction.

What of the dominant volume of supply, food? There were two types of food supply, *frumentum*, or the grain ration; and *cibaria*, the non-grain ration. Appian, a contemporary of Hadrian's,[51] lists corn

[47] Breeze, 1984, 269-71.
[48] Supra Roth, 1999, 2.
[49] Roth, 1999, 3.
[47] Breeze, 1984, 275-6, lists: ' 'surveyors… ditchers, farriers, architects, pilots, shipwrights, artillerymen, glaziers, smiths, arrowsmiths, coppersmiths, helmet-makers, wagon-makers, roof-tile makers, swordcutlers, water engineers, trumpet-makers, horn-makers, bow-makers, plumbers, black-smiths, stonecutters, limeburners, woodcutters, and charcoal-burners.' In the same category are usually included butchers, huntsmen of sacrificial animals, the workshop sergeant, and so on.'
[51] *c*.A.D.95-*c*.A.D.165.

(wheat or barley), sour wine (*acetum*), salt, cheese, bacon-fat (*laridum*) and olive-oil as key components of the Roman military diet.[52] To start the process of understanding the scale of the supply to the Wall, the numbers of those involved is key.

§ 9.3.1 | The Number of Mouths

There is a long history of discussion concerning the size of the Roman army in Britain. Figures as high as 63,000 men have been proposed for the province as a whole[53] whilst 30,000 soldiers have been suggested for the north of the province.[54] The incomplete nature of both the archaeological and the documentary record, since the two are inconsistent, affects the estimates of numbers. It is not sufficient to simply count the number of forts, and the theoretical maximum number of soldiers the barrack blocks could hold. This would not account for units at below maximum strength,[55] or those who had *vexilla* seconded to other forts. This last reason also shows that one simply cannot presume a one-to-one ratio between units and forts. Similarly, *diplomata* dated A.D.98-A.D.146 show a total of 63 or 64 auxiliary units in Britain, during the same period there are only 55 known occupied forts.[56]

Furthermore, there is an issue as to whether 'non-combatant' members of a unit, to use a modern term, should be counted and whether they would have been supplied as part of the same network as the professional soldiers. Such non-combatants include not just slaves, referred to traditionally as *servi*, but specific military slaves, called *calones,* and civilian artisans as well as contractors working for the army, referred to as *lixae*.[57] To give some idea of the scale of

[52] Carreras Monfort, 2002, 72. App., *Hisp.*, 6.9.54: 'They had no wine, no salt, no vinegar, no oil, but lived on wheat and barley, and quantities of venison and rabbit's flesh boiled without salt, which caused dysentery, from which many died.'

[53] Frere, 1967, 309-10; Manning, 1975, 112. Frere notes that this number would be swollen by another 10,000 dependents, up to 73,000.

[54] Breeze, 1984, 269-70.

[55] The Tungrian Strength Report shows the unit in question was at one-third strength, Bowman, 1994, 23.

[56] Breeze, 1984, 266.

[57] Roth, 1999, 93-102.

numbers, the legionary camp at Vindonissa[58] is thought to have had some 2,000 slaves.[59] A combatants/non-combatants ratio of 4:1 has been suggested,[60] for the units on Hadrian's Wall this would create 120 non-combatants per quingenary auxiliary unit, assuming full unit strength. Yet, despite the likely numbers of such people, the Tungrian Strength Report makes no mention of them. Since the purpose of the report is unknown, it may have been for combat trained personnel, this cannot be taken as conclusive evidence that they were not part of the supply network and they are consequently included in the projections for supply.[61]

Given the traditional difficulty in assessing actual numbers of those involved in the building of the Wall, the quantitative survey has provided an alternative means of assessment of the required labour.[62] Thus the environmental model calculates the supply requirement per season of the number of soldiers required to fulfill the construction work. This figure includes the 'non-combatant' *calones* and *lixae* estimated by using the 4:1 ratio that would have accompanied the Roman units wherever they went. However, the numbers of personnel are but one part of the calculation, the numbers of animals are equally important. Unfortunately, their importance to the Roman military, as with Roman roads, is proportional to their literary silence.[63] Using parallels drawn from pre-mechanised armed forces[64] is one of the few methods of

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[58] In modern Switzerland, home, at varying times, to *legio XIII Gemina*, *legio XXI Rapax* and *legio XI Claudia*.

[59] Whittaker, 2002, 208.

[60] Roth, 1999, 114.

[61] Indeed, Bowman & Thomas, 1994, 180 seems to show that a slave of Lucius was in receipt of the same rations as the soldiers. Whittaker, 2002, 209.

[62] As §3.4.1, §4.8.4 and §4.10 note, non-military labour may have aided on- and off-site tasks, but cannot be quantified. All quantified tasks are thus presumed military.

[63] Kissel, 2002, 158, for roads. Logistics is under-mentioned in general in ancient and modern sources, Roth, 1999, 157; however, the use of mules in the ancient world is well documented, Laurence, 1999, 123.

[64] Roth, 1999, 3. Whilst other historic parallels are not relevant, see §9.2 and Engels' use of modern intelligence, the use of animals in pre-mechanised armies is as valid for the Napoleonic era as it is the Roman. With secure testament of ancient use of animals for the military this discussion is firmly rooted in the Roman age. See Laurence, 1999, Chp.9 for similar methodology on mules; see Liv. 4.41.8, 9.14.15, 25.13.6, 27.43,10; Polyb. 3.55.5; Caes. *BAfr.* 9.1, *BCiv*. 2.1.4 for military animal use.

estimating the number of animals the military could have used. Multiple estimates are proposed spanning a large range: the lowest estimates 60 per legion,[65] the highest some 1,500 per legion.[66] Beyond the level of a single unit are estimates for the army of the province, *c*.135,000 animals,[67] and those for the 'army of the north', 16,500.[68] Similarly, specific campaigns find themselves with projections for animal numbers, Peddie used Breeze's estimate of 3,050 baggage animals for Agricola's force of 21,000 men.[69] The complexity of these figures can be seen in their inclusion of such aspects as animals for sacrifice, and leather for tents. This may have required 2,000 animals for an auxiliary unit even before 'shoes, saddles, shields and shield covers, bags, purses, cases, and clothing' are considered.[70] However, these items need not be considered in this thesis as they are not part of 'everyday' supply.

As with non-combatants, it is the ratio that is most important figure for estimating the total numbers of animals per unit. Comparative data from Napoleon's Russian campaign of 1812, along with the American Civil War, show that person/animal ratios of 1:3 and 1:2 respectively were feasible.[71] This evidence is borne out when considering, first, the legions, with an estimate of two mules per *contubernium*,[72] plus sixty for the cavalry, another sixty for the centurions and a 5% reserve pool (in this case, 70 animals) totalling

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[65] Petrikovits, 1975, 58.

[66] Roth, 1999, 82-3.

[67] Whittaker, 2002, 232.

[68] Breeze, 1984, 271. This figure includes cavalry mounts and 2,500 animals per year for sacrifice. The 'army of the north', however, is not clearly defined.

[69] Peddie, 1987, 29.

[70] Breeze, 1984, 272. This figure includes the officers' tents. Without them a total around 1,800 animals is required.

[71] Roth, 1999, 83.

[72] Based on the amount of equipment a *contubernium* would have to carry, distributed between eight men and two mules. Roth, 1999, 77-8.

1,400 animals per legion of 4,800, or a ratio 1:3.4.[73] More relevant for Hadrian's Wall are the auxiliary numbers, these are stressed as conjectural by Roth, due to a lack of evidence, and comprise a marginally higher ratio than the legions of 1:3. These are summed up on Table 9.1:

Table 9.1			
Unit Type	Animals (Infantry)	Animals (Cavalry)	Total
Cohors Quingenaria	160	-	160
Cohors Milliaria	320	-	320
Ala Quingenaria	-	275	275
Ala Milliaria	-	550	550
Cohors Equitata Quingenaria	160	70	230
Cohors Equitata Milliaria	320	140	460

Table 9.1: Number of horses per auxiliary unit type.

Whilst this list theoretically allows an estimate of the numbers of animals utilised on the Wall, it is connected to full strength units. As has been seen, this may not be the case, and the Tungrian Strength Report can be cited once more as evidence to the contrary. It is, therefore, more accurate to use the ratio that establishes these figures, and apply it to the results of the quantitative survey. This 1:3 ratio is used, the results are displayed on Table 9.2 alongside the quantitative labour demand and the number of non-combatants.[74] The animal ratio includes the non-combatant figures as they would have had similar needs to the soldiery in aspects such as movement.

[73] Roth, 1999, 77-8, 82-3. Interestingly, Roth notes that a *contubernium* could be ably supplied with only one mule, this would allow up to five days of rations. Obviously the second mule would be able to increase the amount of rations carried, and thus the amount of time a *contubernium* could operate without resupply. This is very important when one considers that the *contubernium* may well be the basic unit used when manning the milecastles and turrets of Hadrian's Wall. This can, also, potentially cut down the number of mules per legion by 600, to a total of 756, giving a new ratio of 1:6.3.

[74] It should be noted that labour supplemented by non-Romans would affect the number of soldiers who needed supplying, bringing down the total demands.

Table 9.2									
Year / Category	A.D. 122	A.D. 123	A.D. 124	A.D. 125	A.D. 126	A.D. 127	A.D. 128	A.D. 129	A.D. 130
Persons Required	991	9,691	8,766	4,267	4,267	4,758	3,323	1,315	1,315
Non-combat	248	2,423	2,192	1,067	1,067	1,190	831	329	329
Animals Required	413	4,038	3,653	1,778	1,778	1,983	1,385	548	548

Table 9.2: Number of animals per building season.

Kendal estimates a total of 5,200 mules and 1,800 oxen to complete the work in seven building seasons,[75] each extra building season sees a fall in required animals of *c*.16.5%. Thus, for the nine seasons presumed in this model Kendal's figures can be modified down to 3,432 mules and 1,188 oxen. This total of 4,620 animals is similar to the higher figures estimated here, labour demand per building season is significantly lower than A.D.123 for much of the building period giving little reason for the military to requisition extra animals for the purpose of construction. Thus it can be seen that construction would not have required significantly more animals than the units would have possessed normally.

§ 9.3.2 | Consumption

With estimates of both personnel and animals involved in the construction work of the Wall, how much food would they actually consume? This process will consider the food demands of the personnel, their draft animals, and the animals forming the meat supply separately, allowing the total pressure exerted on the land to be calculated. The animals' demands will first be considered in fodder grown specifically for their consumption in line with the treatment of personnel, followed by an exploration of pasturage. The two categories are related, though pasturage is capable of replacing or supplementing fodder demands.

[75] Kendal, 1996, 146.

§ 9.3.2.1 | Personnel Consumption

According to the United States Quartermaster Corps, maintaining combat conditions for a soldier requires an intake of some 3,600 calories per day with at least 70 grams of protein per day needed to prevent malnutrition.[76] As is clearly the case with this source, it is a modern measure designed for modern soldiery. Such figures are subject to alteration along lines of age and size, fundamentally the average Roman soldier was not the same as his 20th century American counterpart. As a consequence, these figures have been extrapolated to account for a soldier 30 years of age, 1.7m (c.5'6") tall and weighing 66 k.g. (*c*.10 stone, 3 lbs.): the result is a daily requirement of 3,240 calories and an intake of 60g of protein for a very active man, and a requirement of 4,000 calories for an exceptionally active man, in accordance with the FAO/WHO's food requirements survey.[77]

Of equal importance to the food intake is that of water, with every soldier requiring two litres on top of the two that would be gained through breathing and food consumption.[78] Indeed, such is the importance of water that camp and fort locations are often dictated by its presence. This does provide something of a compound benefit, not only is it important for those in the camp, as noted by Polybius amongst other ancient authors,[79] but is is also vital in creating and maintaining connexions to the supply network.[80]

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[76] Engels, 1978, 123.

[77] Erdkamp, 1998, 29. Roth, 1999, 12 rounds the calories down to 3,000. Foxhall & Forbes estimate an average calorific requirement for civilians in Rome of 2,583. This is likely to be too high due to the FAO/WHO overestimating child calorific requirements and the over-representation of adults in the model, 1982, 71-2. This measure is described as '*extremely* generous', *Ibid*., 49 fn26, thus a value 20% lower, *c*.2,000 calories, is selected for Roman civilians, clearly lower than the military.

[78] FAO/WHO, 1973, 107-8, Table 31; Roth, 1999, 119.

[79] Polyb. 6.39.9. See also Plut. *Sulla* 16.1; Caes. *BGall*. 4.11.4; *BCiv*, 3.66.6; [Caes.] *BAfr*. 76.2.

[80] The use of the Tyne-Solway isthmus instead of Stainmore Gap can, perhaps, be attributed to the presence of water. Both areas show almost identical development in terms of forts and numbers of soldiery, the main difference is the abundance of water. Discussed in greater depth in §5.4.

Water could also extend the life and use of other supplies. Sour wine and vinegar (*acetum*), had become part of a soldiers' ration by the late-Republic. These were vital sources of both liquid and nutrition, one litre of wine, at 12% alcohol by volume, can provide 700 calories and both are antiscorbutic. It was the norm during the Roman period for wine to be 'watered down', effectively doubling this ration at a very low cost, with the compound benefit of the alcohol's antibacterial properties.[81] The importance of a good fresh water source is highlighted by its ability to extend the liquid ration.[82]

Having established the calorific, protein and liquid requirement, how could this be met? According to Polybius, whom Peddie cites, each man was issued with 3 lbs (1.36kg) of grain a day.[83] However, citing the same source, in conjunction with Pliny, Manning believes that a ration of 2 lbs (0.9kg) would have been the norm.[84] This discrepancy is due, in part, to the problems with converting ancient weights and measures to their modern counterparts. For example, Stolle's *Der Römische Legionär und sein Gepäck (Mulus Marianus)*, from 1914, converted ancient weights to modern equivalents to a 'precision' of three decimal places. These figures, which incurred heavy criticism, were stressed as estimates with the 'precision' an unavoidable result of the quantitative process.[85] This is further compounded by the *c*. 10% difference in weight between milled and unmilled wheat.[86] Engels cites 900g (2lbs) of wheat as being reasonable for Alexander the Great's army.[87] The latest studies of Roman logistics as a whole provide figures of *c*.850g (1.87 lbs.) per day of unmilled wheat for

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[81] Roth, 1999, 37, 40.

[82] The Wall's natural water supply was supplemented by cisterns at sites like Housesteads, and aqueducts supplying many forts. Many of these are not Hadrianic in date, Chesters' two aqueducts are post-Hadrianic, with Benwell, Halton Chesters, Housesteads, Great Chesters and Birdoswald all possessing aqueducts of indeterminate date, Stephens, 1985, 229-30.

[83] Polyb. 6.39.13; Peddie, 1987, 30.

[84] Manning, 1975, 112; Pliny, *NH* 17.67.

[85] Roth, 1999, 4.

[86] Engels, 1978, 123-4.

[87] Engels, 1978, 123-4.

the grain ration,[88] in line with this thesis' methodology, this lower figure is chosen here.

This volume of wheat contains *c*.3,000 calories and 90g of protein,[89] however, the process of turning wheat into bread or biscuit reduces the calorific content to 2,500 and increases the protein to 100g. This is then reduced by the high cellulose content of wheat affecting digestion, 10% of calories and 20% of the protein are lost.[90] This results in a daily intake through wheat of 2,250 calories and 80g of protein, accounting for *c*.57-70% total calorie requirement depending on activity levels. A soldier's protein requirement could be fulfilled through his grain ration alone.

Whilst these figures are for the WHO's 'very active' and 'extremely active' categories, a sedentary army would not have exerted dramatically fewer demands on its soldiery. The prevalence of sports grounds and the Hadrianic emphasis on drilled soldiery[91] result in a Roman army that would still be considered 'very active' by the FAO/WHO report.[92] The 'very active' category includes unskilled labourers, some agricultural labourers, forestry workers, miners and steel workers as well as army recruits and soldiers on active duty. This list includes many of the activities of construction as well as agricultural work, thus the soldiers building the Wall, and those working on food supply, would still have been classified as 'very active'.[93] Combat is considered 'extremely active', which would see the proportion of a soldier's daily requirements supplied by grain fall

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[88] Erdkamp, 1998, 29-31, 35 for unmilled wheat; Roth, 1999, 43, table III.

[89] Erdkamp, 1998, 29; Engels, 1978, 123.

[90] Engels, 1978, 124.

[91] Mattern, 1999, 199-200, 206-7.

[92] For military activities' energy use see FAO/WHO, 1973, 109, Table 34. Route marching is more demanding than patrol, for example.

[93] Whilst a legion or auxiliary unit would have specialists, listed in Shirley, 2000, 92 fn12, the vast majority of the soldiery would be less-skilled labourers working in teams with the specialist, or completing tasks which did not require in-depth specialisation. See Shirley, 2000, 149-54, specifically §7.10.6 and Table 7.50. Some building work is classed as 'moderate activity', FAO/WHO, 1973, 25, in these cases the grain ration would fulfill 79% of the required 2,852 calories. Given this category includes students it is unlikely many members of a military unit would be classified as such.

to 57%, but this category is not relevant for the vast majority of those constructing the Wall.[94]

The grain requirement of those constructing Hadrian's Wall, assuming a ration of 850g per day, can be seen on Table 9.3:[95]

Table 9.3									
Year / Category	A.D. 122	A.D. 123	A.D. 124	A.D. 125	A.D. 126	A.D. 127	A.D. 128	A.D. 129	A.D. 130
Persons Required	991	9,691	8,766	4,267	4,267	4,758	3,323	1,315	1,315
Tonnes Per Year	307.46	3,006.63	2,718.10	1,323.84	1,323.84	1,476.17	1,030.96	407.98	407.98
Non-combat	248	2,423	2,192	1,067	1,067	1,190	831	329	329
Tonnes Per Year	76.94	751.74	679.76	331.04	331.04	369.20	257.82	102.07	102.07

Table 9.3: Personnel grain ration per year.

§ 9.3.2.2 | Draft Animal Consumption

These figures are but one aspect: what of the many animals of which the Roman military made use? The projections supra for the numbers of animals do not take species into account. Their rate of food consumption would vary enormously depending on animal type. This poses an interesting methodological question: are ratios of different animals to be used to calculate consumption; or can average consumption for the species used by the Romans form the basis of the estimations? Given that there is very little data for the ratios of different animals, and that this was likely to be highly variable, the former can be ruled out. However, simply taking an average of the rates of consumption for different types of animals

[94] The late-18th century French army was aware of the extra demand levied on the soldiers by marching, upping the rations with 115 g of bread during such activities. Onasander, a 1st century A.D. philosopher advised extra rationing before bursts of strenuous activity: 'armies have often been overpowered […] their strength failing for lack of food', Onas. *Strat.* 12.1-2. There are a number of examples of an army fighting poorly due to missed meals: Polyb. 11.24.6; Livy 21.54.8, 55.1; Tac. *Hist*. 3.22; App. *BCiv*. 4.16,118.

[95] Tonnage is metric, rather than imperial.

poses problems in that oxen, by far the largest animal, have much greater rates of consumption than other species, yet they would have been more scarcely employed. These rates are shown on Table 9.4:[96]

Table 9.4					
Species	Hard Fodder	Green Fodder		Pasturage	Water
Donkey	1.5 kg	5.0 kg	or	10.0 kg	20 l.
Mule	2.0 kg	6.0 kg		12.0 kg	20 l.
"Pack Animal"	2.0 kg	5.5 kg		11.0 kg	20 l.
Horse	2.5 kg	7.0 kg		14.0 kg	30 l.
Ox	7.0 kg	11.0 kg		22.0 kg	30 l.

Table 9.4: Food and water consumption per animal species.

Consequently, a use of the average would result in oxen skewing the statistics, despite the other four categories of animals having roughly similar consumption rates. The solution lies in the use of the median, which takes into account the higher values of the oxen, without allowing it to unduly skew the statistics. This results in the following median consumption, shown on Table 9.5:[97]

Table 9.5				
Hard Fodder	Green Fodder		Pasturage	Water
2.0 kg	6.0 kg	or	12.0 kg	20 l.

Table 9.5: Median animal consumption.

With this rate of consumption established, it is possible to estimate the total supply requirement for the animals of the Hadrian's Wall area. The total figures for the working animals' annual consumption are show on Table 9.6:

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96 Information taken from Roth, 1999, 66-7.

97 Figures for the average: hard fodder, 2.5kg.; Green Fodder, 5.7kg.; Pasturage, 11.5kg.; Water, 20 l.

Table 9.6									
Year / Category	A.D. 122	A.D. 123	A.D. 124	A.D. 125	A.D. 126	A.D. 127	A.D. 128	A.D. 129	A.D. 130
Animals Required	413	4,038	3,653	1,778	1,778	1,983	1,385	548	548
Hard Fodder Tonnes	301.49	2,947.74	2,665.23	1,297.94	1,297.94	1,447.59	1,011.05	400.04	400.04
Green Fodder Tonnes	904.47	8,843.22	7,995.69	3,893.82	3,893.82	4,342.77	3,033.15	1,200.12	1,200.12
Pasturage Tonnes	1,808.94	17,686.44	15,991.38	7,787.64	7,787.64	8,685.54	6,066.30	2,400.24	2,400.24

Table 9.6: Total annual consumption by working animals for the Wall.

Clearly, the yearly demands placed upon the system of supply and the land by the animals far outstripped those of the soldiery, requiring almost three times the amount of food.[98] For ease of comparison the total demands of the Hadrian's Wall army are shown together on Table 9.7:

[98] This problem was especially acute for armies on the move, Erdkamp, 1998, 12, and may have been a contributing factor to the rise of 'Marius' Mules'.

Table 9.7			
Year	Number	Grain Requirement per Year	Total
A.D.122	991 soldiers	307.46 tonnes	1,590.36 tonnes
	248 non-combatants	76.94 tonnes	
	413 animals	1,205.96 tonnes	
A.D.123	9,691 soldiers	3,006.63 tonnes	15,549.33 tonnes
	2,423 non-combatants	751.74 tonnes	
	4,038 animals	11,790.96 tonnes	
A.D.124	8,766 soldiers	2,718.10 tonnes	14,058.78 tonnes
	2,192 non-combatants	679.76 tonnes	
	3,653 animals	10,660.92 tonnes	
A.D.125	4,267 soldiers	1,323.84 tonnes	6,846.64 tonnes
	1,067 non-combatants	331.04 tonnes	
	1,778 animals	5,191.76 tonnes	
A.D.126	4,267 soldiers	1,323.84 tonnes	6,846.64 tonnes
	1,067 non-combatants	331.04 tonnes	
	1,778 animals	5,191.76 tonnes	
A.D.127	4,758 soldiers	1,476.17 tonnes	7,635.73 tonnes
	1,190 non-combatants	369.20 tonnes	
	1,983 animals	5,790.36 tonnes	
A.D.128	3,323 soldiers	1,030.96 tonnes	5,332.98 tonnes
	831 non-combatants	257.82 tonnes	
	1,385 animals	4,044.20 tonnes	
A.D.129	1,315 soldiers	407.98 tonnes	2,110.21 tonnes
	329 non-combatants	102.07 tonnes	
	548 animals	1,600.16 tonnes	
A.D.130	1,315 soldiers	407.98 tonnes	2,110.21 tonnes
	329 non-combatants	102.07 tonnes	
	548 animals	1,600.16 tonnes	

Table 9.7: Annual consumption of personnel and animals per year.

It is apparent from these figures that the scale of the difference in supplying personnel and in supplying their animals is significant. The majority of the supply is for the animals. The difference between supplying the 'non-combatants', the *calones* and *lixae*, accounts for a 25% increase, a noticeable though not insurmountable increase, especially given the scale of the animals' supply.

As noted, grain provided *c*.57-70% of the daily calorie requirement, consequently other food sources were needed. Some of these foodstuffs were not dependent on the land in the Tyne-Solway isthmus, olive oil and wine for example could not be grown in the region and thus had to be transported. These two foodstuffs supplemented the military diet,[99] with olive oil adding an estimated 350 calories and 10g of protein, and wine or vinegar supplying an extra 190 calories.[100] Combined with the grain ration, this would raise the total to 93% of daily calorific requirements.

§ 9.3.2.3 | Meat Consumption

Though the Roman army was considered 'mainly a vegetarian army' by Haverfield,[101] meat was a staple part of the Roman military diet.[102] Standard equipment for a Roman soldier included a roasting spit, and there are many roles in the Roman military associated with butchery, hunting and tracking of animals.[103] Furthermore, there are many textual references to the consumption of all kinds of meat, such consumption when grain supplies were abundant show that meat was part of the normal supply for the Roman military.[104] The

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[99] For volumes of olive oil and wine supply see Roth, 1999, 35-40.

[100] Roth, 1999, 43.

[101] Haverfield, 1922, 182, though, as noted by Roth, 1999, 27, this idea was challenged early on by Stolle, 1914, 19-20.

[102] Davies, 1989, 191.

[103] Erdkamp, 1998, 32; Roth, 1999, 27.

[104] Erdkamp, 1998, 33. Beef is attested in Sall. *Iug*. 29.6, 44.5, 90.2, 91.1; Plut. *Cato Min*. 56.3; App. *Hisp*. 9.54, *BCiv 3.8.49* and Caes. *BGall*, 5.21.6, 6.1, 6.3.2 *BCiv* 1.48, 3.47.6. Pork in Polyb. 2.15.2-3; *HA Hadr.* 10.2. Mutton in Front. *Strat*. 3.14.4; Jos. *BJ* 4.436.

method of supply for an army not on campaign is relevant here.[105] Were the animals kept on- or near-site, and raised with the produce of the land, an even greater demand on the land would have been exerted. As has already been seen, the demands of an army's animals far outstripped those of its personnel.

There is a paucity of evidence regarding the meat ration when compared to grain for the Republican and Imperial periods. Consequently Late Roman sources must be cautiously used: the *Codex Theodosianus* cites five Roman pounds of pork per month to be added to the *annona*, the civilian grain dole.[106] This equates to 50g a day and this low figure was almost certainly a supplement rather than a full ration. Papyrological evidence from Egypt cites one Roman pound of meat a day,[107] this ration was probably intended to feed the family of a soldier as was the norm in the late Empire. A figure of one-half a Roman pound, 163g, is thus considered likely for modelling here. This would have supplied an extra 640 calories and 15g of protein to a soldier's diet.[108]

Whilst this seems low in comparison to 18th and 19th Century European armies, which would consume 400-500g of meat a day,[109] the high proportion of the calorific requirement already met by grain, oil and wine mean that meat formed a smaller component of the military diet in the Roman era. Furthermore, a meat-based diet was considered decadent and not befitting of a soldier.[110] Thus this seemingly low figure of 163g seems appropriate for both cultural and dietary reasons. The extra calories of the meat ration account

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105 The nature of the literary evidence for supply concentrates on campaigns as these were more likely to attract discussion than the sedentary soldiers. On campaign herding by the soldiery is attested and appears to have been the method of supply for an army's meat, Erdkamp, 1998, 32.

106 *Cod*. *Theod*. 14.4.10.3

107 Roth, 1999, 32; *CPL* 199.

108 Roth, 1999, 43. The protein count would raise to 32g were pork issued instead of beef or mutton.

109 Erdkamp, 1998, 33.

110 Tac. *Ann*. 14.24, when speaking of Corbulo's supply notes: 'He bore indeed the same or even more burdens than the common soldier', eadem pluraque gregario milite tolerantis. See Roth, 1999, 32 for further examples.

for the remaining 7% of the daily intake for a 'very active' soldier, providing a total of 3,430 calories, 106%, for this activity level.[111] Thus some account is made for the increased demand that could take place as a soldier moved beyond 'very active' to 'extremely active' duties.

Unfortunately, as with the units' working animals, there is a lack of evidence for the composition of the meat supply. The bones of oxen occur most frequently on Roman sites in the north, there is also evidence for mutton and pork,[112] and areas such as the Po specialised in breeding pigs for export to the military.[113] Consequently a similar methodology for calculating the composition of the meat supply is taken to the working animals, supra. This is connected to the amount of usable meat that could be butchered from an average animal. The average, rather than the median, is used to account for the presumed increased regularity of oxen, the results are shown on Table 9.8:[114]

Table 9.8		
Animal	Weight	Weight of Meat
Ox	363 kg	202.5 kg
Pig	55 kg	41.25 kg
Sheep	36 kg	19.80 kg
Average	151.33 kg	87.85 kg

Table 9.8: Usable weight of meat per animal type.

Thus, with the average animal yielding 87.85kg of edible meat it is possible to estimate the number of animals required to supply the military's meat. This is shown on Table 9.9:

[111] The protein provision is even higher, with a minimum 95g provided to meet the 60g requirement, a total of 158%.
[112] Davies, 1989, 191-3; Roth, 1999, 28.
[113] Erdkamp, 1998, 33; Polyb. 2.15.
[114] Information taken from Roth, 1999, 29-30, weights adjusted for ancient animal size.

Table 9.9									
Year / Category	A.D. 122	A.D. 123	A.D. 124	A.D. 125	A.D. 126	A.D. 127	A.D. 128	A.D. 129	A.D. 130
Persons Required	991	9,691	8,766	4,267	4,267	4,758	3,323	1,315	1,315
Tonnes Per Year	58.96	576.57	521.24	253.87	253.87	283.08	197.70	78.24	78.24
Animals Needed	672	6,564	5,934	2,890	2,890	3,223	2,251	891	891
Non-combat	248	2,423	2,192	1,067	1,067	1,190	831	329	329
Tonnes Per Year	14.75	144.16	130.35	63.48	63.48	70.80	49.44	19.57	19.57
Animals Needed	168	1,641	1,484	723	723	806	563	223	223
Total Animals	840	8,205	7,418	3,613	3,613	4,029	2,814	1,114	1,114

Table 9.9: Animals needed to fulfill meat ration of personnel.

With the number of animals to be consumed estimated, their supply is calculated. Pigs and sheep generally need 2-2.5% of their body weight per day of green fodder and 1-2% of their weight for hard fodder, pasturage is twice the amount of green fodder.[115] In both these cases the average is chosen, giving 2.25% of body weight for green fodder, and 1.5% for hard fodder. The hard and green fodder requirements of the oxen are already noted.[116] Thus, the average intake of these three animals are used to represent an animal bred for consumption. Consequently, the requirements of the Roman 'average animal' per day are shown on Table 9.10:

[115] Roth, 1999, 64.
[116] See Table 9.4.

Table 9.10				
Species	Hard Fodder	Green Fodder		Pasturage
Oxen	7.00 kg	11.00 kg	or	22.00 kg
Pig	0.825 kg	1.2375 kg		2.48 kg
Sheep	0.54 kg	0.81 kg		1.62 kg
Average	2.79 kg	4.35 kg		8.70 kg

Table 9.10: Average fodder and pasture consumption for Roman meat animal.

Whilst the demand this placed upon the land could be modelled in the same manner as the military's other animals, this would not account for meat that was supplied from outside the province and did not rely on locally fed and slaughtered animals. Salted meat, which kept for a long time,[117] and animals were transported around the empire.[118] The predominance of legs and shoulders of beef on military sites in the north show that preparation was taking place off-site, with the cuts then being moved to supply the soldiery.[119]

However, as with so many aspects of supply, there is a lack of evidence regarding how much was imported, and how much was reared in the local environment. This undoubtedly varied from province to province, and from situation to situation, and both sources were used: the evidence for import has already been seen, and the inclusion of a roasting-spit in a soldier's equipment[120] shows that they would expect to deal with freshly slaughtered animals. Consequently, an arbitrary value of 50% is chosen to represent the amount of meat that would have been produced locally, with the

[117] Appian records that before the siege of Mutina, Decimus Brutus slaughtered and salted the cattle in preparation for a long stay: 'He slaughtered and salted all the cattle he could find there in anticipation of a long seige, and awaited Antony', App. *BCiv*. 3.8.49. Vegetius, *Mil.* 4.7, recommended the slaughter and salting of animals at the first sign of invasion: 'Not only pork, but every kind of animal which cannot be kept enclosed should be sent for curing', Non solum autem porcinum sed et omne animalium genus, quod inclusum seruari non potest, deputari oportet ad laridum.

[118] The breeding of pigs in the Po valley has already been mentioned, Erdkamp, 1998, 33; Polyb. 2.15; the fort of Asciburgium used domesticated animals including a breed that had been specially imported, Requate, 1961 in Davies, 1989, 206. Seafood was also moved from coastal areas inland by great distances, Davies, 1989, 193-4.

[119] Huntley, 2002, 85-8.

[120] Erdkamp, 1998, 32.

remainder imported. This percentage is chosen to represent the Wall's situation as being part of a pre-existing province with an established trade and supply network. The annual grain requirement of the animals forming the meat ration is shown on Table 9.11:

Table 9.11									
Year / Category	A.D. 122	A.D. 123	A.D. 124	A.D. 125	A.D. 126	A.D. 127	A.D. 128	A.D. 129	A.D. 130
Animals Required	420	4,103	3,709	1,807	1,807	2,015	1,407	557	557
Hard Fodder Tonnes	427.71	4,178.29	3,777.06	1,840.16	1,840.16	2,051.98	1,432.82	567.22	567.22
Green Fodder Tonnes	666.86	6,514.54	5,888.96	2,869.06	2,869.06	3,199.32	2,233.96	884.38	884.38
Pasturage Tonnes	1,333.71	13,029.08	11,777.93	5,738.13	5,738.13	6,398.63	4,467.93	1,768.75	1,768.75

Table 9.11: Fodder and pasture required for meat animals.

The fodder demands placed upon the landscape are not as straightforward as the working animals. This is because the animals for meat were slaughtered throughout the year. This study assumes that the consumption of meat took place at a steady rate throughout the year, and that the most fertile month of June[121] would support the most animals, declining steadily throughout the year. The year is divided into 12 equal months of 30.42 days each. The results can be seen on Table 9.12.[122]

[121] Hyland, 1990, 92, Table 3.
[122] Full calculations can be found in Appendix 6.

Table 9.12					
Year	Animal Number	Killed per Month	Hard Fodder	Green Fodder	Pasturage
A.D.122	420	35	231.67 tonnes	361.21 tonnes	722.43 tonnes
A.D.123	4,103	342	2,263.24 tonnes	3,528.71 tonnes	7,057.41 tonnes
A.D.124	3,709	310	2,045.91 tonnes	3,198.86 tonnes	6,379.71 tonnes
A.D.125	1,807	151	996.75 tonnes	1,554.08 tonnes	3,108.15 tonnes
A.D.126	1,807	151	996.75 tonnes	1,554.08 tonnes	3,108.15 tonnes
A.D.127	2,015	168	1,111.49 tonnes	1,732.96 tonnes	3,465.93 tonnes
A.D.128	1,407	118	776.11 tonnes	1,210.06 tonnes	2,420.13 tonnes
A.D.129	557	47	307.24 tonnes	479.04 tonnes	958.07 tonnes
A.D.130	557	47	307.24 tonnes	479.04 tonnes	958.07 tonnes

Table 9.12: Meat animal support requirements per year.

When combined, on Table 9.13, with the personnel and working animals, the total demands on the land per year can be seen.[123]

[123] Table 9.14 combines the totals for soldiers and non-combatants from Table 9.8 in to the ‘Personnel’ category.

Table 9.13			
Year	Number	Grain Requirement per Year	Total
A.D.122	1,239 personnel	384.40 tonnes	2,183.25 tonnes
	413 working animals	1,205.96 tonnes	
	420 meat animals	592.89 tonnes	
A.D.123	12,114 personnel	3,758.37 tonnes	21,341.28 tonnes
	4,038 working animals	11,790.96 tonnes	
	4,103 meat animals	5,791.95 tonnes	
A.D.124	10,958 personnel	3,397.86 tonnes	19,294.54 tonnes
	3,653 working animals	10,660.92 tonnes	
	3,709 meat animals	5,235.76 tonnes	
A.D.125	5,334 personnel	1,654.87 tonnes	9,397.46 tonnes
	1,778 working animals	5,191.76 tonnes	
	1,807 meat animals	2,550.83 tonnes	
A.D.126	5,334 personnel	1,654.87 tonnes	9,397.46 tonnes
	1,778 working animals	5,191.76 tonnes	
	1,807 meat animals	2,550.83 tonnes	
A.D.127	5,948 personnel	1,845.87 tonnes	10,480.18 tonnes
	1,983 working animals	5,790.36 tonnes	
	2,015 meat animals	2,844.45 tonnes	
A.D.128	4,154 personnel	1,288.78 tonnes	7,319.15 tonnes
	1,385 working animals	4,044.20 tonnes	
	1,407 meat animals	1,986.17 tonnes	
A.D.129	1,644 personnel	510.05 tonnes	2,896.49 tonnes
	548 working animals	1,600.16 tonnes	
	557 meat animals	786.28 tonnes	
A.D.130	1,644 personnel	510.05 tonnes	2,896.49 tonnes
	548 working animals	1,600.16 tonnes	
	557 meat animals	786.28 tonnes	

Table 9.13: Total support requirements per year.

§ 9.3.3 | The Problems of Carrying Capacity

Having established the total requirement per year of those building Hadrian's Wall, the next step is to see how much the local land could contribute to this demand. This is no small task, as the data is suited to assessing long term trends and patterns rather than individual events like the construction of the Wall or the arrival of thousands of soldiers.[124] As a consequence, it is wise to apply caution and note that the figures presented in this section are, by necessity, conjectural.

There are many questions relating to the land around the Wall: does the received wisdom of the Wall's environs as 'economically retarded and environmentally disadvantaged'[125] with a low carrying capacity,[126] affect the amount that the Roman army could supply? Similarly, there is the presumption that both the climate and the soil conditions would make the area around Hadrian's Wall less fertile than southern Britain.[127] Considering all of these perceptions, was it, as is often mentioned, an outright impossibility that the Roman military could self-supply from the land?[128]

Firstly, at the time of the Wall's construction the landscape was not of dense woodland,[129] but open with considerable available pasture.[130] Furthermore, the weather was very similar to today's climate, being neither too dry or wet to harm potential growth.[131]

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[124] Barber *et al*., 1994, 33, 49; Fowler, 2002, 64.

[125] Higham, 1991, 93, 94.

[126] Higham, 1989, 155-8, 165-6.

[127] van der Veen, 1992, 1. Higham, 1989, 155: 'The result [of the climate] is leaching throughout the year, and the consequent acidity, exclusion of oxygen and low fertility'.

[128] Carreras Monfort, 2002, 73: 'the *limes* of Britain or Germany could not supply enough corn for the army stationed there, let alone liquids such as sour wine or olive oil, which were produced in more southern latitudes'; Whittaker, 2002, 224: 'the majority of the forts and *vici* in the North of Britain were located in Highland zones, where self-sufficiency from this source alone [nearby land] would have been impossible'.

[129] The open landscape results in no need for vegetation height to be included in the GIS model. See §4.14.

[130] van der Veen, 1992, 12; Barber *et al*., 1994, 49; Tipping, 1997, 242-3; Fowler, 2002, 58.

[131] van der Veen, 1992, 5; Fowler, 2002, 52.

Would this open landscape have been exploited, or simply considered too 'environmentally disadvantaged'? Cord rig in and around the Wall area certainly indicate a tradition of pre-Roman arable exploitation.[132] Similarly, the Romans have a tradition of utilising land that could be considered marginal,[133] there is no reason why the north of England, home to thousands of soldiers, would have been any different. Indeed, it is likely that such a dense concentration of personnel would have promoted resource exploitation.

Having established the need to supply the personnel and animals; as well as a history of land exploitation: what would be the land requirements? Despite the quite detailed estimates of demand, crop yields are difficult. Because the landscape around Hadrian's Wall has been managed, used and altered since the Roman era, modern estimates for carrying capacity will bear little or no relation to those at the time of the Wall's construction.[134] This is further compounded by post-18th century advances in chemistry, physics and soil biology, as well as mechanisation, having a huge effect on modern crop growth.[135]

The solution, in line with the methodology of this thesis, is to select a low yield, and use this in the calculations therein. This at the very least gives an idea of the pressure exerted on the land by the demands of the military. Manning's quantification of the carrying capacity of the land in Wales[136] is a useful model for application to

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[132] Bidwell & Watson, 1996; Hodgson *et al.*, 2001; Huntley *et al.*, 2007, 2-3.

[133] Manning, 1975, 114; Fowler, 2002, 283; Hitchner, 2002, 77, discusses the increase in oleoculture in North Africa as much as 600 m above sea level in previously unworked marginal land. Similarly, in the Libyan pre-desert cultivation of many crops including luxury foods took place throughout the Roman period, Barker, 1996, 224-5, 254-63. This process included heavy expenditure on wadi walls, *Ibid*., 224.

[134] van der Veen, 1992, 8; Roth, 1999, 138.

[135] Fowler, 2002, 50. Interestingly, Fowler considers any advances which resulted in increased yields would have been stumbled upon through trial and error. This he attributes to the fact that 'society as a whole had no testable, rational idea why these things were so', *Ibid*., 257. However, Rykwert, 1976, 31, considers that such advances, whilst not derived from the scientific method, would have been rendered first in mythical or ritual terms.

[136] Manning, 1975.

the Hadrian's Wall area. Here an abnormally low yield of 10 bushels an acre is presumed. This is one-third the modern yield on chalk in an area considered 'exceptionally retarded', furthermore, a yield this low would be poor by the pre-mechanised standard of the 18th century.[137] Consequently, this low yield is applied to the area around Hadrian's Wall.

§ 9.3.4 | Quantifying the Demands on the Land

Roth's figures of 850g of grain a day are for wheat.[138] One bushel of wheat grain is the equivalent to 27.22kg.[139] Thus ten bushels per acre equates to 56.13 metric tonnes per km^2. However, assessing the needs of animals is not as straightforward as calculating the grain supply for the personnel. This is due to animals needing different types of fodder in varying amounts; hard fodder, which is some type of grain product; and green fodder, which are crops designed specifically for animal consumption.[140] This is further complicated by the different types of crops having different yields, for example, bluegrass weighs 6.35kg per bushel, whereas millet is 22.68kg per bushel. Evidence taken from desiccated horse dung at Bearsden, Scotland, showed a diet of barley and wheat for hard fodder, and clover and vetch for green fodder.[141] Where bushel weights differ, an average is used to account for regional variation in fodder composition.[142]

Firstly the hard fodder: the average bushel weight of wheat, 27.22kg, and barley, 21.77kg, equate to a yield per square kilometre of 60.52 metric tonnes. Secondly the green fodder: both clover and vetch

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[137] Manning, 1975, 112.

[138] Supra.

[139] All weights and measures for bushels taken from Murphy, 1993.

[140] Roth, 1999, 61. See §9.3.3, Table 9.7, supra, for the total fodder consumption of animals by type per year.

[141] Knights *et al.,* 1983, 143; Roth, 1999, 61. Though the clover and vetch may have been the result of natural growth rather than deliberately cultivated for fodder.

[142] Bearsden, for example, shows much wheat and little barley in the hard fodder diet, the opposite to Lancaster's results, cf. Davies, 1971; Wilson, 1979; Knights *et al.*, 1983.

have a 27.22kg bushel weight, thus a ten bushel yield equates to 67.25 metric tonnes per km^2. Combining all these factors results in the total land demand created by the personnel and animals constructing the Wall, this includes the further one-third crop yield required for the following year's seed corn. The results are shown on Table 9.14:

Table 9.14				
Year	Number	Land Requirement per Year (km^2)	Total (km^2)	Including Seedcorn (km^2)
A.D. 122	1,239 personnel	5.72	33.94	45.14
	413 working animals	18.43		
	420 meat animals	9.80		
A.D. 123	12,114 personnel	55.88	331.77	441.26
	4,038 working animals	180.20		
	4,103 meat animals	95.69		
A.D. 124	10,958 personnel	50.52	299.95	398.94
	3,653 working animals	162.93		
	3,709 meat animals	86.50		
A.D. 125	5,334 personnel	24.61	146.09	194.31
	1,778 working animals	79.34		
	1,807 meat animals	42.14		
A.D. 126	5,334 personnel	24.61	146.09	194.31
	1,778 working animals	79.34		
	1,807 meat animals	42.14		
A.D. 127	5,948 personnel	27.44	162.93	216.69
	1,983 working animals	88.49		
	2,015 meat animals	47.00		
A.D. 128	4,154 personnel	19.16	113.78	151.33
	1,385 working animals	61.81		
	1,407 meat animals	32.82		
A.D. 129	1,644 personnel	7.58	45.03	59.89
	548 working animals	24.45		
	557 meat animals	12.99		
A.D. 130	1,644 personnel	7.58	45.03	59.89
	548 working animals	24.45		
	557 meat animals	12.99		

Table 9.14: Land requirements to meet full support.

As can be seen, including seed corn, between *c*.40-450km^2 land was required across the Tyne-Solway isthmus for full support of both personnel and animals. There is a great increase in demand in A.D. 123-4, consequently production may have been much higher in A.D. 122 to cope with the influx of personnel to work on the Wall. The average land use across the whole construction period was *c*. 200km^2 per season, it may have been the case that this amount of land was exploited in order to account for fluctuations in labour. Furthermore, whilst there are peaks in demand, there are also significant troughs, meaning that the local market would have been flooded with surplus grain, most notably this would occur in A.D.125. This may have aided the Roman economic realignment of the Hadrian's Wall area, effectively handing control of the agricultural market over to the military. Importantly, the units would have been insulated, to a certain extent, from the wild swings in net demand through their granaries. Quantitative survey alongside Classical evidence has shown that units' *horrea* would have been able to hold food supply for one year.[143] This could have been vital when poor harvests, or inefficient farming, were unable to meet large increases in demand such as that seen between A.D.122 and A.D.123.

§ 9.3.5 | Labour Requirements of Supply

The drain on labour caused by the supply can be estimated through the demand placed on the land by the soldiery, their attendants and the animals. This involves estimating the total labour input required to work the land. As noted,[144] Columella's *De Re Rustica* provides in-depth estimates for the number of person days that each task related to farming the land would require, these are summarised by White[145] and repeated here on Table 9.15. These figures are per *iugerum*, which is 0.65 acres or 0.00263km^2. They are also for

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[143] Rickman, 1971, 237-8; Davies, 1989, 187; Tac. *Agr*. 22.2-3, states 'these positions were secured from protracted siege by a year's supply', nam adversus moras obsidionis annuis copiis firmabantur.

[144] §4.13.1, Columella *Rust*. 2.12.

[145] White, 1965, 102-3.

lighter Italian soils, however, as the only ancient source giving any idea of the labour demands of Roman agricultural practice they are adopted here. Columella does, however, take into account the working of heavier soils. Harrowing would not have been required on good soils and is thus assumed to have been needed in northern Britain as this model is based on poor soils with lower than normal yields.[146]

Table 9.15		
Activity	Person Days	Total Hours
Ploughing	4	32
Harrowing	1	8
First Hoeing	2	16
Second Hoeing	1	8
Weeding	1	8
Reaping	1.5	12
Total	10.5	84

Table 9.15: Columella's labour requirements per iugerum*.*

Columella also claims that agricultural work could have taken place over 250 days of the year, rather than the 200 day building season assumed in this study.[147] Columella's figures, whilst related to the mediterranean climate, are preferred here due to their direct relevance to agricultural. Labour estimates are made assuming total support for the animals, for consistency with personnel calculations. Pasturage will be considered in due course.

Taking the total land demand estimated in §9.3.5 with 84 hours of work required per *iugerum* results in the following estimates of labour demand, shown on Table 9.16:

[146] See §9.3.4.
[147] Columella *Rust*. 2.12.8-9, allowing for 45 days for rain and holidays and 30 days of post-sowing rest.

Table 9.16				
Year	Area incl. Seedcorn (km^2)	*Iugera*	Person Hours	Total Persons
A.D.122	45.14	17,161.34	1,441,552.64	721
A.D.123	441.26	167,749.97	14,090,997.56	7,046
A.D.124	398.94	151,661.48	12,739,563.96	6,370
A.D.125	194.31	73,867.64	6,204,881.43	3,103
A.D.126	194.31	73,867.64	6,204,881.43	3,103
A.D.127	216.69	82,378.05	6,919,756.06	3,460
A.D.128	151.33	57,531.02	4,832,605.91	2,417
A.D.129	59.89	22,767.58	1,912,476.93	957
A.D.130	59.89	22,767.58	1,912,476.93	957

Table 9.16: Labour needed per year for full supply.

The impracticality of supplying all the military's animals with grain grown on the landscape is highlighted in the total labour requirement: the building team of A.D.122, totalling 1,239 persons including non-combatants, would have needed *c*.60% of its labour force to supply itself. This would have been closer to 75% were the agricultural season limited to 200 days. This is clearly impractical.

Breaking down the demands of the personnel, working animals and cattle for consumption, it is possible to see where this imbalance occurs. Table 9.17 shows the different elements of the work study for A.D.122:

Table 9.17				
Group	Area incl. Seedcorn (km^2)	*Iugera*	Person Hours	Total Persons
Personnel	7.60	2,889.99	242,759.57	122
Working Animals	24.51	9,318.54	782,757.63	391
Meat Animals	13.02	4,952.80	416,035.44	209

Table 9.17: Breakdown of supply labour in A.D. 122 per group.

As can be seen, supplying the personnel with grain occupies 116 persons from a labour pool of 1,175, a mere *c*.10%.[148] Clearly, it is the total support of the animals that caused the largest drain on the labour. Consequently it is necessary to explore pasturage as a solution to the labour-intensive nature of supporting the Roman military's animals.

There is evidence for the supply of cavalry horses in the Roman military, with 5-7kg of barley issued as part of the daily rations,[149] and the sensitivity of horses to their diet was also noted by ancient authors.[150] Thus, it seems likely that cavalry horses would have been supplied in a similar manner to the personnel, with the pack animals and those bound for slaughter supported through pasture. How many of a unit's working animals would be horses, and potentially supplied by the more labour intensive method? Table 9.2, shows how many horses an auxiliary unit would possess. Part-mounted units have a ratio between cavalry and working animals of 1:2.2. Applying this ratio to the total number of working animals in a unit gives the following numbers, shown on Table 9.18:

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148 This would be even lower on more fecund land without the need for harrowing.

149 Erdkamp, 1998, 37; Roth 1999, 63.

150 Polyb. 3.87.2-3.

Table 9.18			
Year	Total Number of Working Animals	Number of Cavalry Mounts	Number of 'Other' Animals
A.D.122	413	188	225
A.D.123	4,038	1,836	2,202
A.D.124	3,653	1,660	1,993
A.D.125	1,778	809	969
A.D.126	1,778	809	969
A.D.127	1,983	902	1,081
A.D.128	1,385	630	755
A.D.129	548	250	298
A.D.130	548	250	298

Table 9.18: Number of cavalry mounts per year of construction.

The land dependency caused by this number of cavalry mounts is not as simple as calculating the amount of hard and green fodder they would require. The grazing of horses was attested in antiquity by Vegetius,[151] and some of a horse's fodder requirement could be provided through grazing.[152] Some grain, however, was required in order for a horse to be fully healthy,[153] thus the hard fodder of barley already mentioned as part of a cavalryman's ration is presumed to have been grown, with pasturage forming the rest of the diet. As seen on Table 9.4, a horse would consume 2.5kg of hard fodder, assuming the same bushel yield as above and including seed corn for the following year, the land and labour demand made by horses is shown on Table 9.19:

[151] Veg. *Mil.* 3.8.
[152] Hyland, 1990, 92-3; Roth, 1999, 64.
[153] Hyland, 1990, 70.

Table 9.19					
Year	Cavalry Mounts	Hard Fodder Per Year	Area (km^2)	Hours Required	Persons Needed
A.D.122	188	171.55 tonnes	3.77	120,378.40	61
A.D.123	1,836	1,675.35 tonnes	36.81	1,175,610.35	588
A.D.124	1,660	1,514.75 tonnes	33.29	1,062,915.67	532
A.D.125	809	738.21 tonnes	16.22	518,011.31	260
A.D.126	809	738.21 tonnes	16.22	518,011.31	260
A.D.127	902	823.08 tonnes	18.09	577,560.20	289
A.D.128	630	574.88 tonnes	12.63	403,395.71	202
A.D.129	250	228.13 tonnes	5.01	160,077.66	81
A.D.130	250	228.13 tonnes	5.01	160,077.66	81

Table 9.19: Labour needed for hard fodder supply to cavalry mounts per year.

The labour demand exerted by the need to supply hard fodder to horses accounts for a mere c.5% of the total labour pool. This is far less than supplying all fodder demands through cultivation and is clearly a far more likely supply situation. Whilst pasturage does markedly lighten the labour burden, it is not a year-round solution. The nutritional value of grass varies throughout the year, ranging from virtually non-existent through to comparative fecundity.[154] Thus animals needed total support during the four winter months from November to February, and partial support for two months of late autumn and early spring. The exact nature of this partial support is difficult to quantify, thus an arbitrary figure of 50% is selected, for horses, according to Table 9.4, this is 3.5kg. The full land and labour cost for the winter support of horses through the growth of green fodder for November to February is shown on Table 9.20, alongside partial support in October and March:

[154] Information taken from Hyland, 1990, 92, Table 3.

Table 9.20							
Year	Cavalry Mounts	Support Type	Green Fodder	Area (km^2)	Hours Required	Persons Needed	Total
A.D.122	188	Full	160.11 tonnes	3.16	101,116.21	51	64
		Part	40.03 tonnes	0.79	25,279.05	13	
A.D.123	1,836	Full	1,563.66 tonnes	30.92	987,496.57	494	618
		Part	390.92 tonnes	7.73	246,874.14	124	
A.D.124	1,660	Full	1,413.77 tonnes	27.96	892,834.59	447	559
		Part	353.44 tonnes	6.99	223,208.65	112	
A.D.125	809	Full	689 tonnes	13.63	435,122.40	218	273
		Part	172.25 tonnes	3.41	108,780.60	55	
A.D.126	809	Full	689 tonnes	13.63	435,122.40	218	273
		Part	172.25 tonnes	3.41	108,780.60	55	
A.D.127	902	Full	768.20 tonnes	15.19	485,142.65	243	304
		Part	192.05 tonnes	3.80	121,285.66	61	
A.D.128	630	Full	536.55 tonnes	10.61	338,846.86	170	213
		Part	134.14 tonnes	2.65	84,711.72	43	
A.D.129	250	Full	212.92 tonnes	4.21	134,463.04	68	85
		Part	53.23 tonnes	1.05	33,615.76	17	
A.D.130	250	Full	212.92 tonnes	4.21	134,463.04	68	85
		Part	53.23 tonnes	1.05	33,615.76	17	

Table 9.20: Labour needed for winter supply of cavalry mounts per year.

The support of the horses over winter adds a further *c*.5% to the demands on the labour pool. What of the labour and land demand exerted by the support of working animals over the winter months? Using the consumption rates established on Table 9.5, working animals under partial support would have had an intake of 1kg hard fodder and 3kg green fodder, half the amount needed for animals under full support. The working animals are shown on Table 9.21:

Table 9.21								
Year	Animals	Type	Hard Fodder (Tonnes)	Green Fodder (Tonnes)	Area (km^2)	Hours Required	Persons Needed	Total
A.D. 122	225	Full	54.75	164.25	4.45	142,147.27	72	90
		Part	13.69	41.06	1.11	35,536.82	18	
A.D. 123	2,202	Full	535.82	1,607.46	43.56	1,391,147.95	696	870
		Part	133.96	401.87	10.89	347,786.99	174	
A.D. 124	1,991	Full	484.48	1,453.43	39.39	1,257,845.40	629	787
		Part	121.12	363.36	9.84	314,461.35	158	
A.D. 125	969	Full	235.79	707.37	19.17	612,180.91	307	384
		Part	58.95	176.84	4.79	153,045.23	77	
A.D. 126	969	Full	235.79	707.37	19.17	612,180.91	307	384
		Part	58.95	176.84	4.79	153,045.23	77	
A.D. 127	1,081	Full	263.04	789.13	21.39	682,938.66	342	428
		Part	65.76	197.28	5.35	170,734.67	86	
A.D. 128	755	Full	183.72	551.15	14.94	476,983.06	239	299
		Part	45.93	137.79	3.73	119,245.77	60	
A.D. 129	298	Full	72.51	217.54	5.90	188,266.16	95	119
		Part	18.13	54.39	1.47	47,066.54	24	
A.D. 130	298	Full	72.51	217.54	5.90	188,266.16	95	119
		Part	18.13	54.39	1.47	47,066.54	24	

Table 9.21: Labour needed for winter supply of working animals per year.

The winter support of the working animals adds an additional *c.* 7% to the labour demand. The support of the animals for consumption is shown on Table 9.22, this was calculated according to the demands of the winter months as calculated through the steady slaughter of cattle from June onwards.[155]

[155] See Table 9.13 and Appendix 6 for full information.

Table 9.22								
Year	Animals	Type	Hard Fodder (Tonnes)	Green Fodder (Tonnes)	Area (km^2)	Hours Required	Persons Needed	Total
A.D. 122	420	Full	142.57	101.88	5.15	164,382.70	83	112
		Part	35.64	50.94	1.79	57,180.82	29	
A.D. 123	4,103	Full	1,392.76	995.28	50.29	1,605,862.43	803	1,083
		Part	348.19	497.64	17.49	558,602.12	280	
A.D. 124	3,709	Full	1,259.02	899.70	45.46	1,451,655.80	726	979
		Part	314.76	449.85	15.81	504,961.07	253	
A.D. 125	1,807	Full	613.39	438.33	22.15	707,237.00	354	478
		Part	153.35	219.16	7.70	246,013.65	124	
A.D. 126	1,807	Full	613.39	438.33	22.15	707,237.00	354	478
		Part	153.35	219.16	7.70	246,013.65	124	
A.D. 127	2,015	Full	683.99	488.78	24.70	788,645.57	395	533
		Part	171.00	244.39	8.59	274,331.77	138	
A.D. 128	1,407	Full	477.61	341.30	17.24	550,682.05	276	372
		Part	119.40	170.65	6.00	191,555.73	96	
A.D. 129	557	Full	189.07	135.11	6.82	218,002.77	110	148
		Part	47.27	67.56	2.37	75,832.65	38	
A.D. 130	557	Full	189.07	135.11	6.82	218,002.77	100	138
		Part	47.27	67.56	2.37	75,832.65	38	

Thus the over winter support of the animals kept for consumption can be seen to require 9% of the total labour pool. When all these aspects are combined, the total result of the drain caused by supply can be seen per year of the Wall's construction. This is shown on Table 9.23.

Table 9.22: Labour needed for winter supply of meat animals per year.

Table 9.23					
Year	Type	Persons Needed	Percentage of Labour	Total Persons	Total Percentage
A.D.122	1,239 personnel	122	10	446	36
	413 work animals	213	17		
	420 meat animals	111	9		
A.D.123	12,114 personnel	1,187	10	4,345	36
	4,038 work animals	2,075	17		
	4,103 meat animals	1,083	9		
A.D.124	10,958 personnel	1,073	10	3,928	36
	3,653 work animals	1,876	17		
	3,709 meat animals	979	9		
A.D.125	5,335 personnel	523	10	1,914	36
	1,778 work animals	914	17		
	1,807 meat animals	477	9		
A.D.126	5,335 personnel	523	10	1,914	36
	1,778 work animals	914	17		
	1,807 meat animals	477	9		
A.D.127	5,948 personnel	583	10	2,134	36
	1,983 work animals	1,019	17		
	2,015 meat animals	532	9		
A.D.128	4,154 personnel	407	10	1,491	36
	1,385 work animals	712	17		
	1,407 meat animals	372	9		
A.D.129	1,644 personnel	162	10	591	36
	548 work animals	282	17		
	557 meat animals	147	9		
A.D.130	1,644 personnel	162	10	591	36
	548 work animals	282	17		
	557 meat animals	147	9		

Table 9.23: Total percentage of labour needed to fulfill pastured supply.

In comparison with Table 9.15, the use of pasturage clearly saves a great amount of labour, halving the amount needed. Using this model it is possible to estimate the total number of persons needed per season of the Wall's construction for both building work, as revealed in Chapter 6, and for supply. This is shown on Figure 9.1:

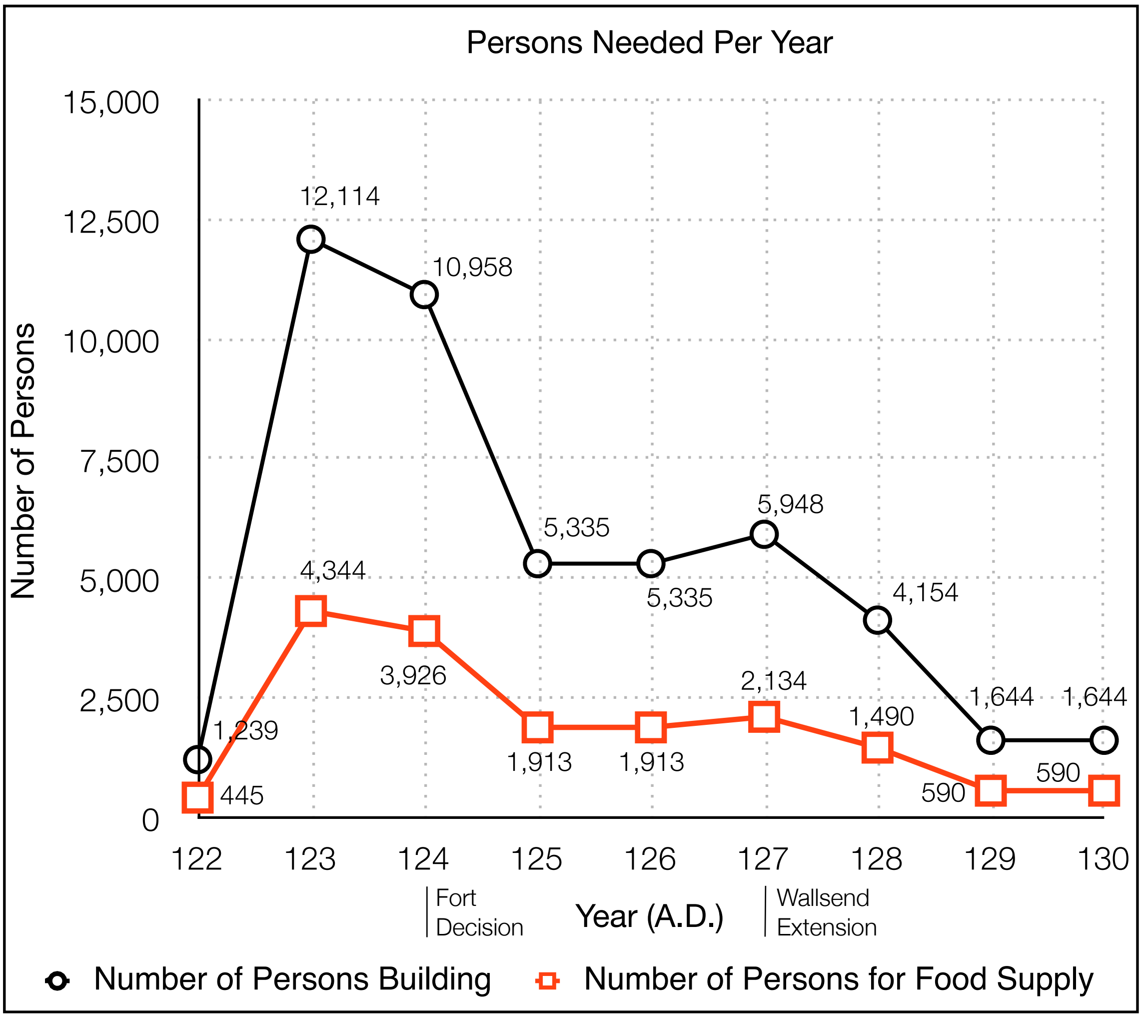

Fig. 9.1: Construction and supply labour demand per year.

The total personnel requirement is shown on Table 9.24:

Table 9.24			
Year	Total Persons Building	Additional Persons for Food Supply	Total Persons
A.D.122	1,239	445	1,684
A.D.123	12,114	4,344	16,458
A.D.124	10,958	3,926	14,884
A.D.125	5,335	1,913	7,248
A.D.126	5,335	1,913	7,248
A.D.127	5,948	2,134	8,082
A.D.128	4,154	1,490	5,644
A.D.129	1,644	590	2,234
A.D.130	1,644	590	2,234

Table 9.24: Total persons needed to fulfill pastured supply per year.

This large amount of agricultural labour has an effect on the landscape which can be quantified through the supply model. The supply of the personnel and horses from grain grown in the landscape requires land to be used. Similarly, the pasture of working animals and those earmarked for consumption also requires land to be set aside for this use. The amount of land needed is shown on Table 9.25, the pasturage land for the two months of partial support is arbitrarily selected to be at 50% fertility to reflect the comparative poor state of the land during October and March.[156]

[156] Hyland, 1990, 92, Table 3.

Table 9.25				
Year	Type	Land Farmed (km^2)	Pasture Land (km^2)	Total Land Used (km^2)
A.D.122	1,239 personnel	7.60	n/a	61.18
	413 work animals	13.29	24.12	
	420 meat animals	6.94	9.23	
A.D.123	12,114 personnel	74.33	n/a	597.93
	4,038 work animals	129.92	235.76	
	4,103 meat animals	67.78	90.14	
A.D.124	10,958 personnel	67.20	n/a	540.59
	3,653 work animals	117.47	213.17	
	3,709 meat animals	61.27	81.48	
A.D.125	5,335 personnel	32.73	n/a	263.32
	1,778 work animals	57.22	103.82	
	1,807 meat animals	29.85	39.70	
A.D.126	5,335 personnel	32.73	n/a	263.32
	1,778 work animals	57.22	103.82	
	1,807 meat animals	29.85	39.70	
A.D.127	5,948 personnel	36.49	n/a	293.64
	1,983 work animals	63.81	115.78	
	2,015 meat animals	33.29	44.27	
A.D.128	4,154 personnel	25.49	n/a	205.08
	1,385 work animals	44.57	80.87	
	1,407 meat animals	23.24	30.91	
A.D.129	1,644 personnel	10.09	n/a	81.18
	548 work animals	17.65	32.00	
	557 meat animals	9.20	12.24	
A.D.130	1,644 personnel	10.09	n/a	81.18
	548 work animals	17.65	32.00	
	557 meat animals	9.20	12.24	

Table 9.25: Land used to fulfill pastured supply per year.

The body of personnel and its animals would have needed an extra *circa* one-third labour to complete its supply, using between 60 and 600 km^2 each year across the Tyne-Solway isthmus. The figures for A.D.123 are close to the projected Wall garrison of *circa* 10,000 soldiers. The 600 km^2 needed through the Tyne-Solway landscape closely reflects the amount of land required for the day-to-day functioning of the Wall once complete. This creates a large corridor *c*.5.6km wide around Hadrian's Wall that must have deeply affected the landscape, expanding the Wall's effects on space from a linear barrier several metres across to a larger order of magnitude. Traversing the Wall exposed any traveller to many kilometres of Roman space, utilised for the benefit of the Roman military. This expanded discrepant experiences and power imbalance across north Britain. Figure 9.2, shows the extent of this effect on the area around the Irthing, derived from the land use figure revealed by the supply survey for A.D.123, and rendered as the shaded area around the Wall's line.[157]

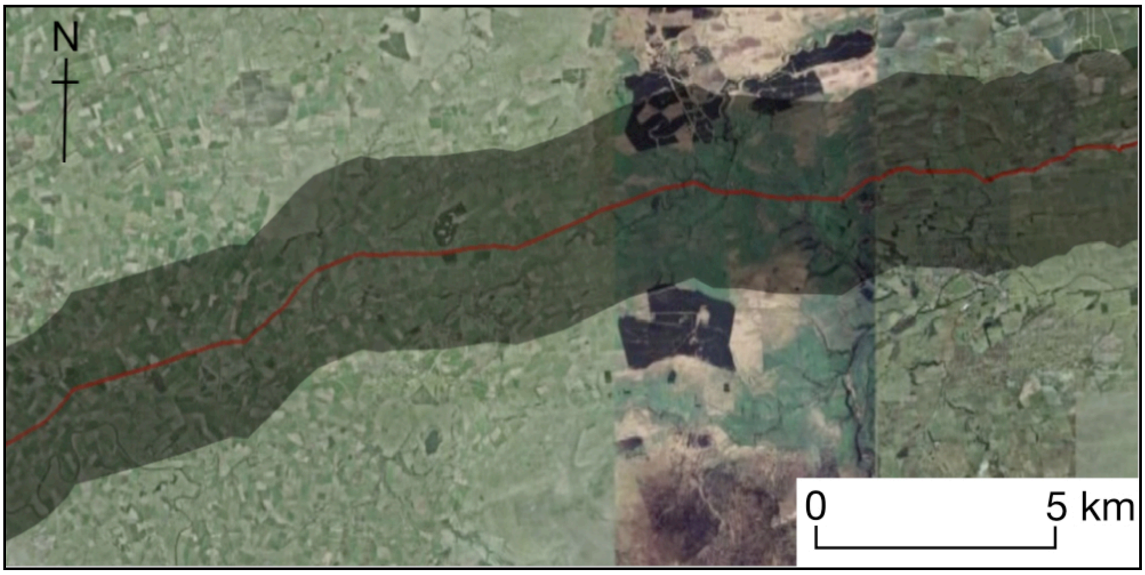

Fig. 9.2: Area used around the Wall for pastured support.

Consequently, it is possible to see that supply was an intrinsic part of the Wall's role in reshaping the landscape to the needs and norms of Rome. Indeed, given the seeming importance of

[157] Fig. 9.2 shows the most basic projection assuming an even spread across the line of the Wall. The reality would have been less linear, with more fertile areas seeing greater exploitation. However, the modelled could not take these into account as the relative fertility of the soil in the Roman era is unknown, see §9.3.3.

Fig. 9.3: The desert surrounds of Gholaia, Bu Njem, in Libya.

native 'settlement landscapes',[158] this feature may have had a far greater impact than the monumental structure of Hadrian's Wall. Indeed, while 10,000 soldiers across the Tyne-Solway isthmus appears to be highly dense, the low levels of soldiers per km have shown that they were not heavily concentrated. The Wall, when compared to twin legionary fortress sites which could house *c*. 12,000 soldiers, was far less concentrated. This spread out the Roman soldiery allowing their presence to affect more of the landscape.

§ 9.4 | The Meaning of Central Supply

The above discussion has shown that local support of the main bulk of foodstuffs was a possibility, however, the inclusion of olive oil and wine as part of the military diet meant that total self-sufficiency was not feasible in the non-Mediterranean areas of empire. It may well be the case that such isolation was never even intended. The placement of forts in remote, environmentally challenging areas certainly implies that self-supply was not a goal in all cases. The

[158] Hingley, 2004, 237. Dark & Dark connect the local continuity of the pre-Roman terrain to a heavily mythological and religious landscape, 1997, 91.

fortress of Gholaia (Bu Njem), shown on Figure 9.3,[159] located in the desert, made self supply through its *territorium* an impossibility.[160] The garrison at the penal mines of Mons Claudianus in the Egyptian desert was another isolated settlement where the existence of a *territorium* could not provide any food. Bulgarian archaeologists have cast doubt on whether there was any agricultural activity taking place in such fort *territoria*.[161]

State sponsored supply of the military is intrinsic to the army's operation and its reception in the landscape. Grain, discussed above, and olives were two of the main staples of the ancient Mediterranean diet;[162] the Roman state took the decision to supply the city of Rome with these two products. Military supply was connected to this decision as the state's experience in providing for the *Caput Mundi* was carried over to the military.[163] Whilst there were significant socio-cultural factors intertwined with the use and supply of foodstuffs, there is also an element of environmental determinism in the decision to supply the military, to a greater or lesser extent, centrally. As the Roman empire expanded beyond the Mediterranean basin, areas were incorporated, such as Britain and Germany, that could not extensively grow grapes or olives for wine and oil.[164] As shall be seen, it is the less quantifiable symbolic connexions that are the driving force behind central supply. Firstly, though, what of the evidence?

The maintenance of the Mediterranean diet had economic, logistical and socio-cultural benefits. At its most basic level, Roman units became engines of demand stimulating production[165] not just in the provinces where they were stationed, but also long distance to areas

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[159] Constructed by *legio III Augusta.*

[160] Whittaker, 2002, 223.

[161] Marichal, 1992, 105 in Whittaker, 2002, 223 fn.71.

[162] Fulford, 2000, 44; Remesal Rodriguez, 2002, 296.

[163] Mattingly, 2007, 220. The Roman military was deeply embedded in politics, Funari, 2001, 242.

[164] Carreras Monfort, 2002, 73; Whittaker, 2002, 219.

[165] Carreras Monfort, 2002, 70; Hitchner, 2002, 73; Remesal Rodríguez, 2002, 295.

of the Mediterranean.[166] These connexions can be traced archaeologically with the movement of different *amphorae* around the empire[167] as well as through the infrastructure of roads, ports and forts set-up to facilitate such transport.

Oil supplied in Baetican Dressel 20 reached soldiers in Britannia, Germania and Raetia.[168] Spanish olive oil seems to shadow the military in Britain;[169] Italian Dressel 6 conveying olive oil to the Danubian *limes* has been found, as has Gauloise 4 supplying wine to the military in Britain and Germany.[170] Similarly, Vindonissa has amphorae that came from as far afield as Surrentum and Messina, and the presence of foreign wine barrels at Vindolanda confirm the involvement of the Tyne-Solway isthmus with such long distance trade.[171] The creation, expansion and maintenance of the land transport network, along with seaborne routes, further aided the movement of supply, goods and commodities. Importantly, this movement stimulated agricultural development in the traditional areas of production as well as prompting growth in other areas.[172] The placement of soldiers far away from the core of Mediterranean production, combined with their centrally administered supply, created a coherent empire where the degree of connexions between the provinces, despite significant regional variation, was quite large.[173]

What of the socio-cultural impact of supply? Whilst central supply, effectively forcing the Mediterranean diet on soldiers throughout the empire, granted a great level of control by the state over its military

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166 Funari, 2002, 244: 'The army was the backbone of the Empire and it is no surprise that whole areas of the Roman world flourished due to army needs.' Central control of supplies could also limit the danger of usurpers, Roth, 1999, 236.

167 Howgego, 1994, 5.

168 Remesal Rodríguez 2002, 307-8; Carreras Monfort, 2002, 81-2, 85: Dressel 20 can account for as much as 60-90% of assemblage weight in Britain during the principate.

169 Funari, 2002, *passim*, specifically 261-2; Mattingly, 2007, 225.

170 Carreras Monfort, 2002, 81-2.

171 Whittaker, 2002, 219.

172 Hitchner, 2002, 73-4, 77. See fn. 93 for specific example.

173 Mattingly, 2007, 222.

its great boon was in building a collective identity[174] and aligning the Roman military, regardless of their origin, with the state whom they upheld and propagated. Of the goods supplied to the military, undoubtedly, the most symbolically loaded in the non-Mediterranean areas of the empire were those that could not be grown locally. Thus olive oil, for example, gained the potent symbolism of being associated with a foreign ruling power.[175] This symbolism could be exploited, not just by those in charge, but by those wanting to connect with the ruling power, or 'join the insiders debate' about Roman culture.[176] This association, and process of acculturation, saw the increase of olive oil consumption amongst non-military populations in the provinces.[177]

However, the web of connexions between the supply of foodstuffs and the consumers is rendered more explicit given the provenance of the materials themselves. That the Mediterranean goods needed to be brought in from far abroad connected the infrastructure of supply to the symbolic power of the food itself. In short, the roads, ports, ships and carts that brought material to Hadrian's Wall were bound up with the effect of the goods transported. Olive oil 'was first a statement of allegiance'[178] which could be connected to the roads that facilitated its supply. The roads aligned the landscape with Rome, and drew a physical connexion back to the Mediterranean heart of the empire.[179] The movement and subsequent use of olive oil made this link physically real on a day-to-day, *praxis*, level.

This web of connexions and symbolism highlights the role of the Roman military in forming new provinces of the empire. The huge

174 Carreras Monfort, 2002, 71-2.
175 Funari, 2002, 263; Remesal Rodríguez, 2002, 300.
176 Woolf, 1994, 11; Haynes, 2002, 114.
177 Remesal Rodríguez, 2002, 300-1.
178 Funari, 2002, 263.
179 Witcher, 1998.

quantities of military labour expended on constructing roads,[180] the military connexion with the running of the *cursus publicus*, the ease with which information and goods could be moved around the provinces and the subsequent realignment of the landscape would have had a far more profound impact on daily life than many give credit:[181]

> 'the laying out of thousands of acres of new fields, droveways, and enclosures represent a far more profound change in the British landscape than did the thinly-spread buildings of a thousand or two fashionable Romanised bungalows'.

All of these factors can be connected directly to military actions: the construction of roads that carried goods, driving the supply of material by creating demand in the provinces, stimulated production elsewhere and provided the means to move goods. All of these are essential ingredients to long-distance supply. In short, the military and its supply was a vehicle of Roman influence[182] leading to people willing to emulate the norms and lifestyle of the classical Mediterranean at the heart of empire.[183] These connexions are further reinforced by the maintenance of the road network,[184] just as their original construction linked the military and the technical skill of Rome to the landscape, so the continuing work by the Roman military on roads and camps alike underscores this relationship.

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180 Maxwell, 1988, 29. It is stated here that 6,000 person days would be required per ten kilometre stretch of road. Kissel, 2002, 130, estimates that the cost of building public roads would be 500,000 HS per mile. This point is emphasised when one consider the representations of soldiers at work, for example, their prominence on Trajan's Column, see §3.4, Fig.3.6, Rossi, 1971, 99, 101.

181 Branigan, 1982, 95 in Fowler, 2002, 283.

182 Funari, 2002, 263: 'The Roman army played a pivotal role in this respect, as its supply network helped to expand Roman values and *mores*.'

183 Fowler, 2002, 283: 'They, with military and political change, induced a socio-economic development which saw, at least in southern Britain, the creation of a materially rich class of landowners introducing or aping Classical *mœurs* and life-style.'

184 Kissel, 2002, 131-2. There is also an association between road-building and politics, demonstrated by both Augustus, Kissel, 2002, 146, and Hadrian, see milestones, supra, Ando, 2000, 306-7, 310, and §3.4.

The military's involvement in the process of becoming Roman, and their central role in constructing the Wall, forms a link between the structure's existence and the spread of Roman culture through control of the landscape. In the south of the province of Britain, there were many identifiable signs of Roman culture which were not evident in the north. This lead to the characterisation of the south as 'the civil zone' and the north as 'military'.[185] This accounts for both the decision to build the Wall; as a response to the comparative paucity of identifiably 'Roman' material culture, as defined by the Romans themselves; and also the continued occupation of the Wall due to the ongoing low level of such indicators.[186]

Central in this lattice of meaning are the auxiliaries, the units stationed upon Hadrian's Wall. The auxiliaries were recruited from areas integrated within the Roman empire and highlighted the benefits of Roman rule through co-operation.[187] This was emphasised by the flow of goods with associations to the ruling power which supported the auxiliaries' lifestyle. Power and its display is thus important to supply. Whilst civilians were relatively free to 'opt-in' to the Roman lifestyle, demonstrated by the accretion of olive oil consumption on civilian sites,[188] central supply forced aspects of the Mediterranean diet upon auxiliary soldiers regardless of personal and cultural tastes.[189]

This does not mean that all soldiers in the Roman army, and thus those on Hadrian's Wall, ate an exclusively Mediterranean style diet. Indeed, there is much evidence to the contrary: the Vindolanda tablets show various soldiers seconded as far afield as Gaul

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[185] Hingley, 2004, 327.

[186] See §3.5. There were many similarities between the meaning of Roman structures and their Iron Age counterparts, however, it is the lack of recognition for this by the Romans which causes their continued occupation of the Wall. Rivet, 1969 in Bidwell, 1997, 41, connects the enduring presence of occupied forts to 'Rome's failure to absorb the areas they controlled into the mainstream of ordinary provincial life'. Hingley, 2004, 333-6 discusses Roman villas and their comparative lack of occurrence around the Wall.

[187] Funari, 2002, 239.

[188] Funari, 2002, 263.

[189] Remesal Rodríguez, 2002, 307-8.

gathering supplies.[190] *Tituli picti*, graffiti found on amphorae of wine, *garum* and oil bound for Hadrian's Wall, mentioned specific people and units involved in supply,[191] and the *Pridianum* from Moesia dovetails with the evidence from the Vindolanda Tablets, showing soldiers sent to remote provinces to collect specific supplies for their units.[192]

So normal was this practice that military specific terms existed for soldiers sent to secure long-distance supplies, *frumentarii*, for example.[193] Similarly, archaeological evidence of beer brewing, which was not part of the Mediterranean diet, is present on Hadrian's Wall[194] as well as the consumption of different types of meat evidenced by the remains of animal bones.[195] These correspond with the diets of auxiliary units' home provinces, showing that some maintained aspects of their traditional foods despite the central supply of key products for a Mediterranean diet. Thus auxiliary units, at the time of Hadrian, were an example of the Roman empire in microcosm, highlighting the mixture of 'native' society within a Roman cultural framework. This also highlights that there was no single solution to supply, and that different sources were utilised depending on the situation of individual units. Auxiliaries were ideal units for the Wall within the Roman framework of using the army, its structures and *mores*, to create new provinces.

Central supply, as noted above, was not just limited to food, but also equipment. Whilst this was not as regular as food supply, it did have an important impact on how the Roman military altered the economy when sedentary. The system of deducting two-thirds pay from a Roman soldier for the cost of their equipment and food supply[196]

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[190] Bowman, 2003, 30-1.
[191] Whittaker, 2002, 211.
[192] *British Museum Papyrus* 2851 and Fink, 1971 in Remesal Rodríguez, 2002, 81.
[193] Carreras Monfort, 2002, 76.
[194] Bowman & Thomas, 1996, 323-5; Roth, 1999, 40; Whittaker, 2002, 220.
[195] Davies, 1989, 191-3; Huntley, 2002, 85. Forts showed variation in diet, with South Shields seeming to have a preference for mutton over beef.
[196] Remesal Rodríguez, 2002, 296.

had two benefits for the state. First, it reduced the amount of coinage that needed to be struck for the military;[197] second, the coin which was supplied could be used to stimulate the local economy, rather than simply going straight back to the state. That the money minted aided the economy can be seen in the types of denominations used: it was for circulation alongside barter[198] and not for modern-style 'credit' based transactions and economies.[199]

The army can once again be associated with this activity. They are one of the key ways in which money was moved throughout the empire, either as the focus of the primary injection of money, or through secondary movement when a unit was deployed elsewhere.[200] Indeed, such was the link between the military and money that some auxiliary units even minted their own officially sanctioned coinage.[201] Similarly, the military can also be connected to other financial aspects, the standardisation of weights and measures were regularly left in the hands of the legions, for example.[202] The military's ubiquity throughout the empire meant their control of such aspects would be of great help to the long distance, cross-provincial trade networks upon which the centrally supported Roman military so relied.

Why is the injection of money and the creation or acceleration of a monetised economy important?[203] First and foremost, the use of money is a force for financial and thus market-based integration between the disparate provinces of the empire.[204] Again, this is an important feature given the needs of central supply, links stretched

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[197] Remesal Rodríguez, 2002, 296.
[198] Haynes, 2002, 120.
[199] Meikle, 2004, 241.
[200] Howgego, 1994, 13, 14.
[201] van der Vin, 2002, 165.
[202] Haynes, 2002, 124.
[203] As an aside, Erdkamp, 2002, 50, notes that army grown surplus, above and beyond the needs of the military, could have been sold on the market. This would show the *territoria* as a vital stimulus in helping to develop the provincial monetary economy.
[204] Jongman, 2002, 38; Hopkins, 2002, 210.

back from the provinces to the Mediterranean area where production of much needed resources like oil or wine was stimulated by the military. Importantly, this stimulated political re-ordering and integration.[205] Soldiers appearing with coinage did not simply speed this process along, though that was undoubtedly a feature; rather they contributed to the realignment of society and its attempted restructuring along Roman lines. This is similar to the manner in which roads, whilst functionally providing access, also realigned the landscape.[206]

This realignment took place due to large numbers of soldiers in areas like Hadrian's Wall, creating new opportunities for both supply and relationships. In short, old dependencies and networks were no longer the only options available.[207] This challenge to existing social relationships allowed new associations to form which were immersed in the Roman provincial *habitus*. This connexion can be seen in the presence of imperial iconography in places where barter, trade and exchange took place.[208] The association of weights and balances with Rome through the legions, and the propagandistic messages on the coins themselves,[209] minted at times by the soldiers, all connect to show a Roman co-option and realignment of economic space driven by the Roman military.

Clearly long-distance supply routes were part of the process by which new provinces were created[210] through their effect on the landscape and the economy of the areas in which the military were stationed. These aspects went hand-in-hand with other

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[205] Hopkins, 2002, 205-6, 224, sees monetary integration following political integration, with rich Romans owning land in the provinces and provincials becoming Roman. However, the process may well be more complex, with a recursive relationship between the two facets leading to the creation of a fully functioning, and profitable, province of the Roman empire.

[206] Witcher, 1998.

[207] Haynes, 2002, 119. Hitchner, 2002, 73.

[208] See Ando, 2000, 212 for portraits in markets, also §3.4.

[209] Haynes, 2002, 124 for legionary control of weights. Howgego, 1994, 15, demonstrates that the ubiquity of Marc Anotony's coinage is commensurate with the political instability of the age. See Ando, 2000, 212 for coinage propaganda.

[210] Mattingly, 2007, 224-5.

developments, the settlements outside Roman forts and fortresses supplemented the effect of coinage in the formation of new dependencies through their 'creation of new centres, or meeting places, which attracted market activity, much but not all of which served the army itself'.[211] These new centres were connected to the military and highlighted the militarily led nature of this process. Thus the Roman army was not solely the force of occupation and violence that is so often assumed. Indeed, coin and the other connected facets of the Roman military presence are all part of a network of meaning which could create a 'new civilisation',[212] that is, Roman provincial civilisation with all the plurality of experience this entails.

§ 9.5 | Conclusions: The Myth of Self Supply

The Roman military presence in the province of Britain is estimated to have caused a population increase of a mere three to five percent.[213] By the time of the Wall's construction the provincial population is thought to have numbered around two million,[214] thus even the whole 'army of the north' working on the Wall, 30,000 soldiers,[215] would account for 1.5% of the population of the province, rising to nearly 1.75% when 'non-combatants' are included. Even during the invasion,[216] the numbers of soldiers were not overwhelming compared to the pre-existing provincial population.

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211 Haynes, 2002, 123. Fowler, 2002, 284: 'Towns prospered too, even those which had not at first 'taken' when planted out in alien country […] for a time it seemed that the very considerable structural investment in the countryside a century or so earlier was paying off in sustained mixed-farming production'.

212 van der Vin, 2002, 168.

213 van der Veen, 1989, 446. Hingley & Miles, 2002, 152-5 include a population breakdown showing that the percentage of population accounted for in the army and its dependents was between 3.5-4%, depending on total population estimates. It must be stressed that any projections of total population for Britain are highly conjectural and have varied considerably through time, Mattingly, 2006, 368.

214 Mattingly, 2006, 293, 368.

215 Breeze, 1984, 269-70.

216 If the units utilised during the invasion were below paper strength, which seems to be the case in both the Vindolanda tablets and the quantitative survey results, then the extra population would be to the bottom end of the 3-5% estimate.

Britain was already producing and exporting surplus items to the continent before the Roman invasion, Tacitus and Strabo mention the material wealth exports of Britain[217] whilst the landscape of the north had been occupied and exploited for the millennia before the Roman conquest.[218] The idea that the Roman military was unsustainable in the province as a whole begins to appear weakened. Indeed, the prosperity of the island may well have played a part in influencing the Roman decision for an invasion.[219] When this surplus is combined with the Roman track record in increasing production and exploiting marginal land,[220] it is possible to see that there may well have been more than enough capacity within the province to cope with this influx of military personnel. In the long term, the setting up of long-distance trade networks would have further supported the military personnel of the province. Clearly, then, the changes to the landscape and day-to-day life within the province under the Romans is not connected to a functional need to increase production, rather it is because of the military's role in creating provinces of a larger empire.[221]

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[217] Tac. *Agr*. 12.6 clearly states that Britain was worth invading: 'Britain produces gold and silver and other metals: conquest is worthwhile', fert Britannia aurum et argentum et alia metalla, pretium victoriae. The appearence of gold and silver as key reasons for an invasion neatly demonstrates how material wealth was used to mediate status, see §3.2 and §6.4.2. A British 'brand image' for cereal, wool and hunting dogs is proposed by Fowler, 2002, 281-2, similar to the status of the Ager Sabinus in Italy for mule breading, Laurence, 1999, 124. Strabo 4.5.2 claims 'grain, cattle, gold, silver and iron are exported from the island, as also hides, and slaves, and dogs that are by nature suited to the purpose of the chase', though 4.5.3 cites Britain as not worth conquering due to the cost of the military operation merely balancing the tribute: 'they submit so easily to heavy duties […] that there is no need of garrisoning the island; for one legion, at the least, and some cavalry would be required in order to carry off tribute form them, and the expense of the army would offset the tribute-money'. Strabo's argument could be political, seeking to justify Augustus' lack of invasion.

[218] Dark & Dark, 1997, Chp.5; Dark, 2000, 58-63, 79-80; Hingley, 2004, 329.

[219] Fowler, 2002, 7.

[220] §9.3.4.

[221] Fowler, 2002, 60, recognises the importance of the effect of remodeling the landscape ahead of functional gains: 'We can sense the inhabitants' sense of proximity, of people bumping into one another as farmers and families adjusted to neighbours new and old as well as to an ancient landscape of traditionally open areas, long-established clearings, former clearings with regenerated scrub and young woods, and new clearings edged by vertical cliffs of bruised but standing trees where the woodsman stayed his axe.'

This study differs from previous attempts at quantifying the supply demands of the Roman army as it is for a static, concentrated body, rather than an invasion or campaign. The Wall was built in the early 2nd century, when Britain had been under Roman control for decades. The units constructing the Wall, by and large, were already in the province and had been supplied without difficulty for some time, it is the concentration of the soldiery rather than the raw numbers which posed the logistical problems. This highlights how the Wall itself led to a restructuring of supply to deliver the goods to where they were needed,[222] rather than the wholesale creation of new supply routes from scratch. Whilst supplying the Wall's work site was undoubtedly a major military action, it could be carried out without many of the negative effects upon supply that are assumed for invading forces.[223] Even land-transport, considered inefficient for invasions,[224] could be utilised because the transport network, including the *cursus publicus*, was already fully functioning. Indeed, it is this network that may have made the Wall project a possibility in much the same way that the trade networks organising the flow of olive oil and marble around the empire required 'infrastructural catalysts'.[225]

The land requirement survey demonstrated the impossibility of total self-supply. It is clear that the Roman military was supported by a bricolage of methods ranging from growth of crops around the sites of forts, to the long-distance trade networks that would supply the northern provinces with mediterranean goods. The involvement of local populations in supply, be it through requisitions of goods or

[222] There is evidence for the movement of people and goods from the south of the province to Hadrian's Wall during the construction phase. See Fulford, 2006, 68-9.

[223] Polyb. 23.15.1, mentions the long-term environmental damage caused by the army: 'I never can share the sentiment of those who exercise their vengeance on those of their own race to such an extent that they not only deprive the enemy of the year's harvest, but destroy trees and agricultural apparatus, leaving no room for redress.' Fowler, 2002, 63: 'the marked change early in the millennium in the agricultural landscape suggests a destructive Roman army.'

[224] Engels, 1978, 129, notes that pack animals could move supplies for a mere five days before they would have consumed all that they could carry.

[225] Howgego, 1994, 5 comments on marble, for more on this see Dodge & Ward-Perkins, 1992. See Hitchner, 2002, 72 for the infrastructure and elements needed for the olive oil trade.

supply contracts, further strengthened Roman control and power over the area. Indeed, this could have been of vital importance as the soldiers building the Wall restricted the opportunities for 'native' involvement. Supply of the worksite was the key function that could mix Roman and 'native' in the landscape in a clear hierarchy, both ostensibly working together to a goal dictated by the Roman state. The large amount of land required, hundreds of square kilometres, expanded the amount of the landscape affected by the Wall's construction. Rather than being a highly-visible yet 'thin' structure cutting across the landscape, demand placed on the land by supply meant that the monument's realignment of space affected a far greater area and brought the structure to ever more people.

For reasons ranging from the symbolic impact of working the land, through to the stimulation of far-off markets, it is undoubtedly an admixture of sources that met the demand of the military units, with the precise composition depending on local factors. This is in no better way illustrated than with the multitude of varying locations for forts across the empire, ranging from the most dry and arid of deserts to prosperous and fecund river valleys. Indeed, it is precisely this flexibility in supply that is part of the reason for the success of the Roman military and, by extension, the structures that it built, including Hadrian's Wall. Thus supplementation of what could be grown in the immediate environs of a fort was not merely helpful to the military units, but appears to have been needed by design. Indeed, it may be the case that terms such as 'central supply', with implications of an almost parental Roman state, are something of a misnomer. 'Central *support*' may be a far more applicable term. Perhaps, most damning for the modern ideal of self-supply, is that a self-contained unit requiring little support from outside and working a *circa* ten square mile box around a fort would be highly counterproductive to the aims of the Roman military: to build new, prosperous provinces linked to the greater whole of the Roman empire. This raison d'être could not be achieved by such an insular *modus operandi*.

X | Conclusion

Hadrian's Wall was primarily devised as a boundary within which romanization was to be developed, and the natural corollary was the growth of farms and villages and towns, settled agriculture and the arts of peace [...]

ERIC BIRLEY, 'HADRIANIC FRONTIER POLICY', 1956, 28.

§ 10.1 | Introduction

This study has examined the Wall in light of its broader Roman context. This has involved considering symbolism as a motive present in both the form and function of Hadrian's Wall. Traditional interpretations, summarised below, have often eschewed this approach, becoming 'narrow, unimaginative, unconcerned with theory and stagnant in methodology'.[1] Thus a concentration on both the broader Roman context, and the wider theoretical context of landscape archaeology, is timely for Hadrian's Wall. In this study, the core methodology of using quantitative survey to assess symbolism is perhaps a surprising inclusion given this approach's usual association with functional questions.[2] However, the importance of effort and scale is a key factor in a structure's symbolic power. It is this kind of connexion, between a seemingly non-quantifiable factor[3] (the importance of effort) and the structure (the choice of labour intensive stone over turf, for example) that highlights the relevance and significance of the quantitative method for the Roman world. This approach results in the Wall's

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[1] James, 2002, 5.

[2] Rickman, 1971, is an example of a quantitative survey used to answer functional questions. In this example the amount of storage space present in Roman fort/ress granaries was analysed. There has been a recent move away from quantitative survey as a solely functional tool, see DeLaine, 1997; Martins, 2005.

[3] Carl *et al*., 2000, *passim*.

interpretation, not as a passive structure designed simply to aid the defence of the province or the empire's treasury, but as an active structure engaged in the dynamic processes of social interaction.

However, this is not to limit the impact or importance of functional approaches both on this study and the Wall in general. Indeed, the functional focus has given Wall studies a deep understanding of Wall anatomy and chronology that is the envy of those who study other Roman frontier works. The core methodology of the once-dominant 'Birley School', centred on assessing the Wall's purpose from internal evidence,[4] provides a rich source of detailed excavations without which this quantitative study would be unfeasible. Consequently, it is impossible for this study not to have relevance to some of the questions of functionalism. The quantitative survey can be used to assess the likelihood of, for example, the building of parts of the Wall by auxiliaries; similarly, the numbers of soldiers required per season casts light on the labour demands across the whole of the construction period. The decisions which shaped the Wall's form, the placement of forts along the line of the curtain for example, can be assessed through the quantitative data.

§ 10.2 | Traditional Views of the Wall

The prevailing views of Hadrian's Wall, despite differing in their minutiae, share various common underlying principles. Firstly, they are mono-causal in nature, ranging from signalling theories,[5] which deal with such factors as the milecastles' variable placements through their need for inter-visibility, to 'Custom Barrier' models, which answer the dichotomy of a porous barrier through its need to allow movement.[6] Finally, military models such as Luttwak's and Donaldson's,[7] presume the Wall was to prevent movement and to allow numerous options in defence and attack, ranging from

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[4] James, 2002, 23.
[5] Woolliscroft, 2001, Chps 2 & 3.
[6] Birley, 1956, 32; Mann, 1974.
[7] Luttwak, 1976, Chp.2; Donaldson, 1988.

'pinning' the attackers against the curtain[8] to combining forces through multiple outlets to meet the enemy in the field.[9] These interpretations are all based around the anatomy of the Wall, they are discussed and developed internally[10] in a dialogue between the structure and the meaning of similar buildings in the modern world.[11] Fundamentally, these interpretations are not composed in relation to the Roman context.

Similarly, despite the interpretations ranging from overtly military to fiscal, they all share a predilection for functionalism. There is little regard for non-material factors that are so important during the act of construction,[12] and material factors are considered the 'ends' of the Wall's purpose. This is best evidenced by the 'Customs Barrier' argument where the collection of money is the ultimate goal rather than one step in a more drawn out conceptual process.[13] Traditionally, actions rather than structures are ascribed accepted symbolic connotations, for example, Hadrian rigorously exercised his soldiery to inspire fear and respect without combat.[14] That building took place symbolically, however, had little influence on the interpretation of the Wall's form or function in the above accounts.

§ 10.3 | A Revised View of the Wall

In recontextualising the Wall, it is important to understand where the functional emphasis of traditional approaches originated. Chapter 2, considered how this manifested itself in modern scholarship.[15] Importantly this has roots in the Victorian era, with the cherry-picking of Classical texts in order to support the Victorian world view. This gave a veil of Classical credibility to analysis which said

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[8] See Richmond's model in Dobson, 1986, 22, Fig.6a.
[9] Luttwak, 1976, Fig.2.4.
[10] James, 2002, 23.
[11] This is especially prevalent in Donaldson's interpretation, Donaldson, 1988, *passim*; Mann, 1990, *passim*.
[12] Rykwert, 1976, *passim*; Carl *et al*., 2000, *passim*.
[13] See §3.2
[14] Mattern, 1999, 199-200.
[15] Specifically §2.4.

more about the Victorian world and its ideals than that of the Roman.[16] Close analysis of the Classical and post-Classical texts mentioning the Wall has demonstrated a symbolic dimension in their treatment of the structure. Similarly, this reinterpretation has highlighted the problems with placing the norms of later times onto the Roman era.[17] These alternative readings demonstrate the Victorian-era norm of emphasising that which best reflected the then contemporary understanding of frontier structures. This could be explicit, with the 'Customs Barrier' argument being illustrated by an elision between the Indian Customs Hedge and Hadrian's Wall;[18] or implicit, in the seemingly natural conflation of people to place in terms of understanding the concept of a frontier.[19]

The separation of functionalism from interpretation of the Wall is vital when also considering the ancillary structures which are assumed to be part of the broader 'Wall system'. This is due to the dislocation in requirements between Victorian and modern frontier works and those of the Roman era. This results in the application of roles that did not exist at the time of the Wall to associated structures. The Outpost forts, and their association with the function of an intelligence screen, are demonstrative of this phenomena which relates the Roman infrastructure to modern conceptual roles that did not exist at the time.[20]

Having examined the root of the functional bias it is important to set the broader context of landscape archaeology in relation to Hadrian's Wall. Chapter 3 concentrated on discussing a theoretical framework that can be applied to Hadrian's Wall. This sought to re-connect the Wall to its Roman context as a structure built by Roman soldiery and based in the broader norms and actions of this institution. Thus, the actions and the purpose of the Roman military

[16] §2.3.
[17] §2.2, §2.2.1-2.
[18] Pelham, 1911, 333.
[19] Mattern, 1999, 5.
[20] See §8.5.

come under scrutiny.[21] Importantly, shorn of the reliance on divisive models,[22] Hadrian's Wall can be considered a structure of interaction, allowing the theory of *praxis* to be used.[23] In this sense, the importance of the use of the Wall is emphasised, however, its use is but one aspect as the Roman principle of *maiestas* demonstrated.[24] This links the quantitative aspects of the study with the symbolic, as effort expended on a structure was a key part of its symbolic message of the majesty and power of its builders.[25]

The reification of concepts goes far beyond this mere representation of effort, it was making a physical representation of a lasting message. Such aspects as Rome's gods, the emperor's presence and the Roman ordering of space are key factors along the line of the Wall.[26] Importantly, this is connected to a social rather than functional role. Ideas of social formation tend to either be bloody, enforced at sword-point;[27] or under a form of peaceful 'self-Romanisation'.[28] However, discrepant power relations appear to represent an underlying factor, forcing either co-operation, as the benefits outweighed the negatives of defiance, or resistance. The latter was a path which the Wall, through its expressions of Roman greatness, or *maiestas*, aimed to show was manifestly doomed. A key part of the Wall's design was to make this statement available to all who traversed the Tyne-Solway isthmus by demonstrating Rome's power and the many and varied aspects of Roman culture that were staged throughout the structure. It is these aspects, and not the 'function' of gathering money or offering protection, which are key to understanding the design and intent behind the Wall.

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[21] §3.4.
[22] See Chps 2 & 3.
[23] Bourdieu, 1990; §3.3.1.
[24] Mattern, 1999, 171; §3.4-1.
[25] Thomas, 2007, 107; §3.3.1, §6.9, Fig.6.15.
[26] §6.9.
[27] Mattern, 1999, 103 stresses that many provinces needed conquering more than once; also see Ando, 2000, XI.
[28] Haverfield, 1905, 185; Luttwak, 1976, 78, 88.

Having studied the roots of the predominance of functional interpretations and outlined a theoretical formula relevant to the Wall, the meaning of the structures can be considered. Chapter 6 argued that the Wall was an active force in social formation, designed to achieve the goal of forming a space subservient to Rome, as the act of passage through the Wall exposed people to many different facets of the Roman world.[29] This can be seen in the architecture, set to overwhelm, the very shapes of the gateways, evoking deities and emperors and even the materials of stone, turf and timber. Furthermore, the layout of multiple sequential boundary crossings provided scope for the repeated restatement of the Wall's messages. This was underlined by the presence of soldiers either actively involved in the process of passage, manning the gates, excise, or indirectly through their high visibility and acts of maintenance. More abstract, however, is the reification upon the Wall of the emperor himself, through a chain of multiple symbolic connexions which could be as diverse and subtle as the shape and materials of the archways through to the connexion of the soldiery to the imperial cult and the power they served. All of these aspects are underscored by the scale of construction and the buildings themselves, as revealed by the quantitative survey.

Key here is the power imbalance and the promotion of *maiestas* of all types. As has been seen, a key aspect of *maiestas* is the effort expended on construction and supply of the worksite.[30] This was emphasised by the repeated working of the ditch and vallum,[31] and the monumental associations of scaffolding with the structures themselves.[32] The amount of effort, and thus the power of *maiestas*, can be seen through a quantitative survey. Throughout, transparency is emphasised as the exact form of the buildings quantified can never be fully known.[33]

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[29] See §6.3.2; §6.4.2; §6.5.2; §6.6.2; §6.7.2 and §6.9.
[30] Quantified and explored in Chps 5-9.
[31] Evans, 1988, 89.
[32] Thomas, 2007, 107; §3.3.1, §6.9, Fig.6.15.
[33] Shirley, 2000, 194.

The quantitative results, aside from giving an order of magnitude to the symbolic message, allow model testing. This results in a minimum requirement of *c*.10,000 soldiers, coinciding with the estimated garrison of the Wall.[34] Furthermore, the fort decision and the subsequent alteration of the curtain wall width has been shown not to be related to concerns of completion time.[35] Similarly, the relative importance of the individual components of the Wall are demonstrated by the full quantitative survey. Perhaps surprisingly the largely turf built vallum is one of the most labour intensive aspects of Hadrian's Wall, demonstrating the importance the Wall's builders placed on turf and timber structures alongside their stone counterparts.[36] Finally, a consideration of the stone re-build of the turf wall highlights the importance of materials in Roman construction.[37] The reconstruction of the Wall west of the Irthing placed greater emphasis on the Vallum as the main method for the Wall to use turf and timber symbolically. The inclusion of stone, turf and timber may have been intended to allow the Wall to convey its symbolic messages in forms familiar to a wide variety of peoples and contexts. This, in part, was connected to the broader Roman context, discussed in Chapter 3, the emperor Hadrian's own policies and the aims of the structure itself.

The groups traditionally associated with the Wall, the Stanegate, Outpost forts and Cumberland coast, have all come under scrutiny. The Stanegate, covered in Chapter 5, is most often seen as a precursor for the Wall.[38] However, reassessment of the Stanegate on both chronological and quantitative grounds reveals a lack of systematic planning and fewer parallels with the Wall than has sometimes been assumed.[39] Model testing, in the form of viewsheds and line of sight analysis, have revealed dislocations

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[34] Breeze & Dobson, 2000, 54; §6.8.1.
[35] §6.8.2.
[36] §6.8; Figs 6.10-2.
[37] §6.8.
[38] Hodgson, 2000.
[39] Hodgson, 2000.

between sites that are supposedly inter-visible.[40] Given the connexion between the Stanegate and the Wall in the signalling model, this is a major result which casts doubt on the idea of the known extent of the Stanegate as a proto-frontier.

Once again, considering the wider context reveals aspects that are often ignored. The parallels between the Stanegate and the Stainmore gap, for example, reveal the latter as having closer conformity to the concept of a frontier.[41] Similarly, the standard layout of Roman roads with forts, is of greater relevance to the development and purpose of the Stanegate than the later addition of the Wall.[42] Removing the Wall's reliance on the Stanegate for its function benefits both structure. Firstly, the Stanegate need not be seen solely in relation to the Wall as a precursor inadequately performing the same functions. Secondly, the Wall itself is now freed from overly-military interpretations which saw the development of the Stanegate and the Wall as one interconnected structure responding to a single, consistent threat.

Whilst it appears that there is no continuity of function between the Wall and the Stanegate, the same cannot be said of the Cumberland coastal system. The installations on the north-western coast of England are often considered extensions of Hadrian's Wall.[43] Whilst the Wall is traditionally ascribed a functional interpretation, this is usually applied to the coastal system as, logically, it is an extension of the Wall and would thus possess the same function. Whilst an aspect of this link can be maintained due to its repetitious anatomy, closer examination of the structure reveals there is a distinct divergence in the functions that it performed. The broad anatomy remains similar, but there are numerous small-scale differences which indicate an alternative function from that of the Wall.[44] This

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[40] §5.4.2-2; contra Woolliscroft, 2001, Chp.2.
[41] §5.4; Fig.5.2.
[42] §5.6.
[43] Birley, 1961, Chp.4.
[44] §7.3.

contrast is all the more pronounced given the results of Chapters 3 and 6, which advocate a move away from functionalism for understanding the Wall. Thus, the change in purpose for the Wall actually reinforces the traditional interpretation of the Cumberland coast: its flexible responses to local situations are far more resonant with functional considerations than the Wall's overly systematic approach. Consequently, the Cumberland coast is seen as functioning to enforce the line of the Wall, stopping circumvention and effectively forcing passage via the Tyne-Solway isthmus. This promoted the symbolic message of the Wall through more than mere functional underpinnings, the active soldiery in the area, for example, reinforced the power imbalance immanent in the structures of the Roman military.

The Outpost forts, covered in Chapter 8, have also been considered to have a function connected directly to that of the Wall.[45] The interpretation of the Wall as a linear defensive or customs barrier meant that the structure needed forward intelligence gathering to operate effectively. However, as with the Cumberland coast, reinterpretation of the Wall's function has ramifications for the Outposts. This study interprets the Wall, not as an hermetic seal on the province, but as an active structure intended for day-to-day use. In this interpretation there is little need for an intelligence screen to the north. The wider context of the Roman world provides comparanda of forts laid out along roads. As with the Stanegate, this is standard across the Roman empire. The connexion of the Outpost forts to Hadrian's Wall can be criticised as a result of their variable chronologies. Thus they are not part of a discrete group[46] and this is reinforced by the quantitative differences seen between the Outposts and the relatively uniform forts of the Wall.[47] Importantly, as with the coast, this arrangement still provided benefits for the Wall's symbolic message, conditioning and

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[45] Mann, 1990; Woolliscroft, 2001, Chp.3.
[46] Table 8.1.
[47] §8.4.1.

realigning space far to the north of the Wall on a provincial level in the manner of Roman roads the empire over.[48]

Finally, examining supply in Chapter 9, provides vital insight into how the Wall was supported. This was not merely feeding the soldiery, but also supporting the Wall's purpose and meaning. The quantitative analysis of the unit's supply requirements shows that part-support from within the region and the province was feasible.[49] This also provided an opportunity for joint interaction in a clearly Roman framework. The amount of land needed to support the construction of Hadrian's Wall would have expanded the Wall's scope for affecting people. This would have had both a profound impact on daily-life[50] and have been part and parcel of building a new Roman provincial identity. It was key for the Wall's symbolic power that it was constructed by the military, though this left little scope for involving the local populace and using the many benefits of *praxis* through joint enterprise. The supply of the work site and the soldiers by the provincial civilians provided opportunities for interaction which would have otherwise been denied. There would have been a clear hierarchy as people worked for the Romans to maintain their supply, and the power imbalance immanent in much of the Wall's structure would have been reinforced. These factors would have helped to construct the concept of a province and are clearly connected to the Wall's purpose of expanding, rather than protecting, the Roman empire.

Many structures of imperial largesse, roads and city walls for example, relied on tax-breaks issued by the imperial *fiscus* for their construction.[51] This was vital in social formation in the Roman world, especially when incorporating new territory. Many of these structures would have been built by local communities, as has been seen this was an aspect denied to the provincial civilians by the

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[48] See Witcher, 1998.
[49] §9.5.
[50] Fowler, 2002, 283.
[51] Black, 1995 32 for Hadrianic road building in Britain.

Wall's military construction. Thus the ability for civilians and 'natives' to become involved in supply takes on added importance. Whilst the Wall was not in 'new' territory, it was nevertheless a massive alteration of pre-existing space. The supply situation thus acted as a proxy for construction for non-military personnel, with all the benefits of *praxis* and social formation that are both congruent with the purpose of the Wall and an effect of the act of construction.

Drawing these many and varied strands together, it is evident that, rather than a static functional or mono-causal structure, the Wall was a dynamic site of social formation and interaction. Eric Birley's quotation, this chapter's epigraph, is correct in that the Wall was intended to contribute towards the development of the province. However, this contribution is not merely passive as he presumes, merely providing security so that the land to the south could be altered along Roman lines. Rather it was actively engaged in the shaping of people through the space they used. The Wall embodied many methods to achieve this goal of expansion, which increased the Empire and the number of those who considered themselves 'Roman'. These were typical goals for Roman emperors, Hadrian and his means of achieving integration was anything but traditional. Indeed, it is only by examining the Wall in its Roman context that the innovative nature of its structure and aims can be revealed. This was accomplished through the use of structures common in the Roman world; the city wall, watchtower, fortlet and fort; but arranged uniquely with both the symbolic power of the original individual parts and that of a completely unique building.

§ 10.4 | Future Directions

This research has many applications beyond Hadrian's Wall which are discussed below. First refinements and further applications of the methodology specific to the Wall will be discussed. Foremost is the need for an Inchtuthil-style quantitative survey of individual structures on the Wall which are well recorded.[52] This is most acutely required in the case of the forts, with perhaps only Housesteads and Segedunum surviving in great enough detail to be surveyed in a manner similar to Inchtuthil. The completion of a more detailed survey of Wall-forts would provide data of direct application to the Wall, and provide comparandum between legionary fortresses and auxiliary forts, highlighting similarities and differences in their construction processes, time required to complete and labour demand. It would also remove the layer of inference required in the application of Shirley's findings and norms to the Wall.

The GIS model utilised in this study could be further refined. The *c.* 10m resolution across the whole of the Wall limits the use of GIS, a broad scale high-resolution model would allow important facets to be explored. For example, do milecastles correlate with paths of least cost for movement across the landscape? Also, smaller area-specific resolutions could be selected to answer certain questions. Such sites as MC42, where the milecastle occurs on a steep bank mere metres away from an easily accessible crossing site, demonstrate why a high-resolution, sub-5m model, is required to answer such questions.

As noted,[53] this study concentrates on the on-site building activities. Whilst consideration is given to the food supply of those building the Wall and its ancillary structures, a more detailed understanding would require greater clarification of the environment and soil fertility at the time.[54] A greater understanding of the carrying capacity of the land would create a more accurate model. Furthermore, the supply of stone, wood and transport costs from quarry to work-site and, in the case of stone, the potential shaping at the quarry site, could also be modelled. This would provide further accuracy in estimating labour demand for the construction and supply of the Wall, with full

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[52] Shirley, 2000.
[53] Chp.4.
[54] Chp.9.

quantification of off-site demands further refining our understanding of the Wall's scale on both provincial and regional levels.

The theoretical framework is developed from a Roman perspective and considers how the structure reflects Roman culture and the aims of the Wall. Clearly, as the people the structure was designed to have the most effect upon were non-Roman, not all of the 'message' of the Wall would have been comprehended. Consequently, the Wall's reception was vital to its success. The theoretical framework has given access to the *intended* effect of the Wall, but its *actual* effect is equally important. However, approaching this question is very difficult as the Roman standpoint is illuminated by a vast corpus of literature and material culture from around the Roman world. The indigenous societies which the Wall affected, however, are visible only in the archaeological record, and sporadically so. One avenue could lie in analysing the means of projecting *maiestas*, and whether such concepts existed within indigenous cultures. Are their means of promoting the types of symbolic message seen on the Wall compatible? Is there a possibility of a shared cultural vocabulary that would render the Wall comprehensible? Examining these questions will lead to a fuller understanding of the Wall's impact at the time of its construction. However, the Wall has a biography that encompasses its use for many hundreds of years. The way the Wall changed in meaning throughout its lifespan, best seen by the interpretation the *SHA* places upon the structure,[55] is vital for seeing the broader conceptual development of frontiers in the Roman world.

Away from the Wall this study has broader applications for other Roman frontiers. Due to the relationship between British Wall scholars and their German counterparts, similar methodologies and theories have been applied to both. This is both a long-standing tradition and part of many current approaches to understanding

[55] See §2.2.1.

Hadrian's Wall.[56] Consequently, the German frontier has similar functional and monocausal interpretations which would benefit from a symbolic and quantitative analysis along the lines developed here. Similarly, the African *fossatum* has also tended to be discussed functionally,[57] due in part to the modern conflation of people to territory and the role of frontiers in the Victorian and modern eras.[58] This opens the *fossatum* to a symbolic re-assessment of its design and purpose.

Whilst this study has had a chronological limit of the Wall's completion, the symbolic reassessment has prompted important questions about the structure's long term role. Given that the Wall was intended to play an active part in 'provincialising' northern Britain, why was it occupied for so long? Settlement is maintained under Roman auspices for several centuries after its construction, and for even longer after the Roman withdrawal. Thus the question of the apparent failure of the Wall, necessitating a longer occupation, must be asked. The answer, however, may be more nuanced. As shown in Chapter 3, a key aspect to the Wall was cultural communication. Whilst this discussed the opportunity for commonality it must also be noted that there was great scope for difference. Thus, it may have been the case that the 'native' population came to see itself as 'Roman', in-part due to the Wall's presence, though the Romans themselves may not have recognised them as such. Furthermore, the Wall's subsequent alterations, seen in the blocking up of many milecastles gateways, may indicate a change in function very soon after completion. All of these aspects are central to understanding the affect the Wall had upon the people in and around its landscape.

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[56] See James, 2002, 16 for long-established tradition; Hodgson, 2000, *passim*. and Woolliscroft, 2001, *passim.* for recent examples.

[57] Guey's interpretation of the *fossatum* as an ancient Maginot Line is an example of this. See Guey, 1939.

[58] See §2.3.

The core methodology, however, is not limited in relevance to Roman frontiers or even just the Roman military. There is a far broader scope of application for this methodology because of the wide range of sources used, from Chapman *et al* to DeLaine and Faulkner,[59] all of whom deal with matters non-military. Military expenditure, for example, could be compared to civilian building programmes within civil settlements. Such approaches could be defined in regional or chronological terms and would give a deeper understanding of the effects of imperial largesse and development in the provinces. Furthermore, the interoperability of pre-existing quantitative studies means that, with some account taken of inflation,[60] the figures are immediately available for comparison.

Finally, the role of the Wall within Hadrian's broader programme is important. Its physical structure is an exemplar of Hadrian's principate in its strikingly different way of achieving the effect of a military 'victory'. When combined with other institutions like the Panhellenium and iconography such as *Disciplina* coinage[61] there are glimpses of a far broader programme of redefining the role of the *princeps* and the methods of achieving this. Hadrian's Wall is but one fraction of this broader programme and a further exploration of this area is required, not only for the Hadrianic period, but for understanding how emperors typified their principates and how they sought to centrally manipulate and control such a vast empire.

Rich Hartis,

Durham,

December, MMIX.

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[59] Chapman *et al*, 1996; DeLaine, 1998; Faulkner, 1998.

[60] Faulkner's figures, for example, are taken from the 1990s, whereas this study's costs are for 2002's levels. See §4.12 and the *Quarterly Building Price and Cost Indices* published by the Department of Trade and Industry.

[61] Mattern, 1999, 206.

Beyond Functionalism

A Quantitative Survey and Semiotic Reading of Hadrian's Wall

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PhD Thesis

Volume II of II

University of Durham

Department of Archaeology

MMIX

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Appendix I | The Stanegate

§ A1.1 | Introduction

This is the data appendix for the quantitative survey of the Stanegate. The following sections explain how to read the results for the structures, highlighting which variables are used in calculations. There are two sets main sets of variables, relating to aspects like the height of walls,[1] one group for stone and another for turf and timber structures. These are shown across the top of the data, see Fig. A1.1, and are referred to throughout the quantitative process.

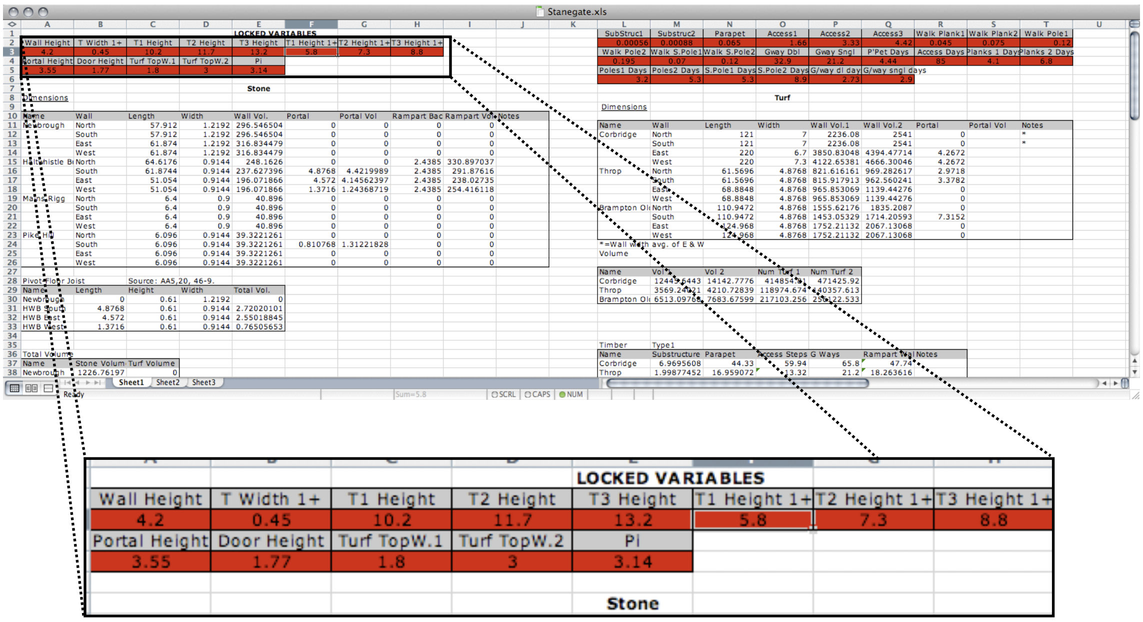


Fig.A1.1: Stone variables used in calculation.

[1] The values of these variables are explained throughout Chp.4.

The variables for stone structures are listed on Table A1.1:

Table A1.1	
Variable Name	Explanation
Wall Height	height of the ground floor structures
Width 1+	wall width of the levels above the ground floor
T1 Height	total height of a Type 1 turret
T2 Height	total height of a Type 2 turret
T3 Height	total height of a Type 3 turret
T1 Height 1+	height of the top two floors of a Type 1 turret
T2 Height 1+	height of the top two floors of a Type 2 turret
T3 Height 1+	height of the top two floors of a Type 3 turret
Portal Height	height of an arched entrance
Door Height	height of a doorway entrance
Turf TopW.1	width of a Type 1 turf rampart's top
Turf TopW.2	width of a Type 2 turf rampart's top
Pi	value of π to two decimal places

Table A1.1: Definition of stone variables.

The variables used for the quantitative calculations for turf structures are shown on Fig. A1.2:

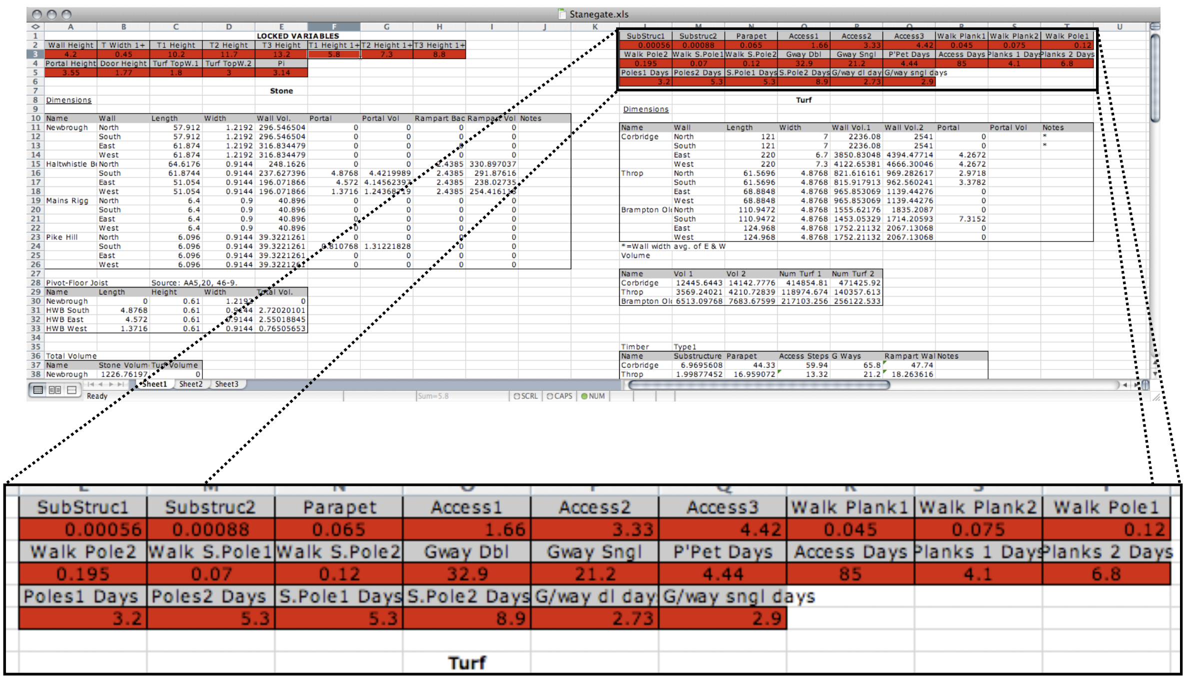


Fig. A1.2: Variables used in turf calculation.

The variables for turf structures are listed on Table A1.2:[2]

Table A1.2	
Variable Name	Explanation
SubStruc1	rampart substructure volume per m^3 turf, 100mm x 50mm timbers
SubStruc2	rampart substructure volume per m^3 turf, 100mm x 100mm timbers
Parapet	parapet volume per m^3 turf, 100mm x 100mm cladding
Access1	rampart access step volume, using 150mm poles
Access2	rampart access step volume, using 150mm x 300mm poles
Access3	rampart access step volume, using 300mm poles
Walk Plank1	rampart walkway plank volume per m^3 turf, Type 1 rampart
Walk Plank2	rampart walkway plank volume per m^3 turf, Type 2 rampart
Walk Pole1	rampart walkway pole volume per m^3 turf, Type 1 rampart
Walk Pole2	rampart walkway pole volume per m^3 turf, Type 2 rampart
Walk S.Pole1	rampart walkway split pole volume per m^3 turf, Type 1 rampart
Walk S.Pole2	rampart walkway split pole volume per m^3 turf, Type 2 rampart
GWay Dbl	double portal gateway volume, including timber towers
Gway Sngl	single portal gateway volume, including timber tower
P'Pet Days	days worked per m^3 of parapet timber
Access Days	days worked per access way
Planks 1 Days	days worked per m^3 of rampart plank volume, Type 1 rampart
Planks 2 Days	days worked per m^3 of rampart plank volume, Type 2 rampart
Poles1 Days	days worked per m^3 of rampart pole volume, Type 1 rampart
Poles2 Days	days worked per m^3 of rampart pole volume, Type 2 rampart
S.Pole1 Days	days worked per m^3 of rampart split pole volume, Type 1 rampart
S.Pole2 Days	days worked per m^3 of rampart split pole volume, Type 2 rampart
G/Way dl Days	days worked per m^3 of double gateway volume
G/Way sngl Days	days worked per m^3 of single gateway volume

Table A1.2: Definition of turf variables.

There now follows examples of the quantitative process for both stone as well as turf and timber structures.

[2] For volumes of timber used per cubic metre of turf see Table 4.1, §4.7.1.

§ A1.2 | Stone Structures

Haltwhistle Burn fortlet, with its high level of survival of both turf and stone features, is chosen to provide a walkthrough of the quantitative process. The site can be seen on Fig. A1.3.[3] First the site is measured, from which volumetric calculations are made. *Step 1* is the calculation of the wall volumes. *Step 2:* three of the walls contained portals, thus their stone volume is calculated.[4] *Step 3:* the rampart backing volume needs to be calculated to give the basic quantitative results.[5] The variables used in these processes are shown on Figs A1.4-A1.6.

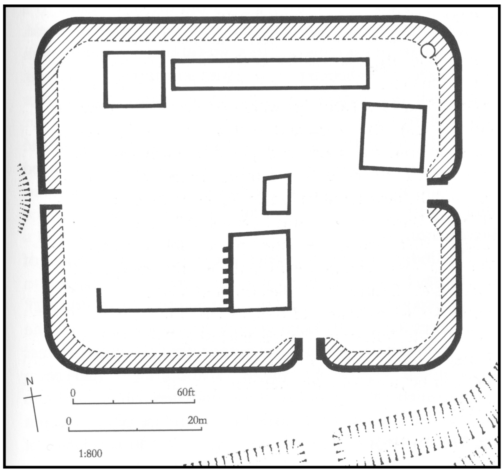
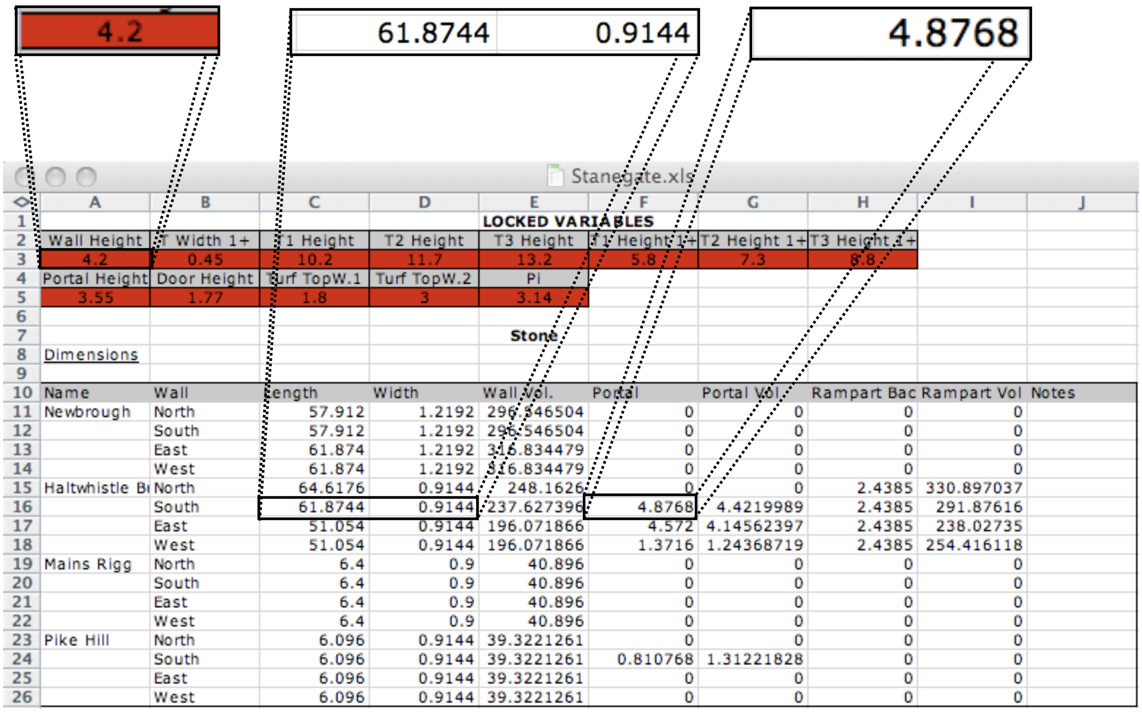


Fig. A1.3: Haltwhistle Burn fortlet layout.

Fig. A1.4: Wall Volume
(l-r) wall height, wall length, wall width, portal width



	A	B	C	D	E	F	G	H	I	J
1					LOCKED VARIABLES					
2	Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+		
3	4.2	0.45	10.2	11.7	13.2	5.8	7.3	8.8		
4	Portal Height	Door Height	Turf TopW.1	Turf TopW.2	Pi					
5	3.55	1.77	1.8	3	3.14					
6										
7					Stone					
8	Dimensions									
9										
10	Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol.	Rampart Bac	Rampart Vol	Notes
11	Newbrough	North	57.912	1.2192	296.546504	0	0	0	0	
12		South	57.912	1.2192	296.546504	0	0	0	0	
13		East	61.874	1.2192	316.834479	0	0	0	0	
14		West	61.874	1.2192	316.834479	0	0	0	0	
15	Haltwhistle B	North	64.6176	0.9144	248.1626	0	0	2.4385	330.897037	
16		South	61.8744	0.9144	237.627396	4.8768	4.4219989	2.4385	291.87616	
17		East	51.054	0.9144	196.071866	4.572	4.14562397	2.4385	238.02735	
18		West	51.054	0.9144	196.071866	1.3716	1.24368719	2.4385	254.416118	
19	Mains Rigg	North	6.4	0.9	40.896	0	0	0	0	
20		South	6.4	0.9	40.896	0	0	0	0	
21		East	6.4	0.9	40.896	0	0	0	0	
22		West	6.4	0.9	40.896	0	0	0	0	
23	Pike Hill	North	6.096	0.9144	39.3221261	0	0	0	0	
24		South	6.096	0.9144	39.3221261	0.810768	1.31221828	0	0	
25		East	6.096	0.9144	39.3221261	0	0	0	0	
26		West	6.096	0.9144	39.3221261	0	0	0	0	

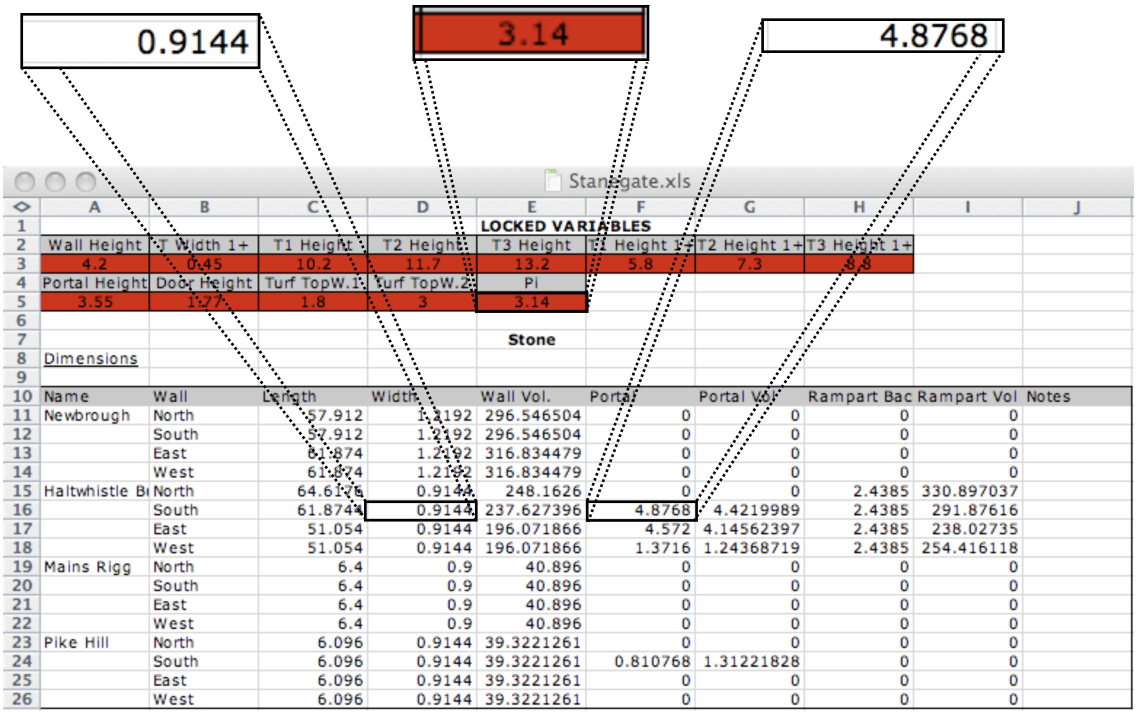
[3] Image from Breeze, 2006, 447. For excavation see Gibson & Simpson, 1909.

[4] For wall and portal volume formulae see §4.4.

[5] For rampart backing formulae see §4.6.2.

Fig. A1.5: Portal Volume

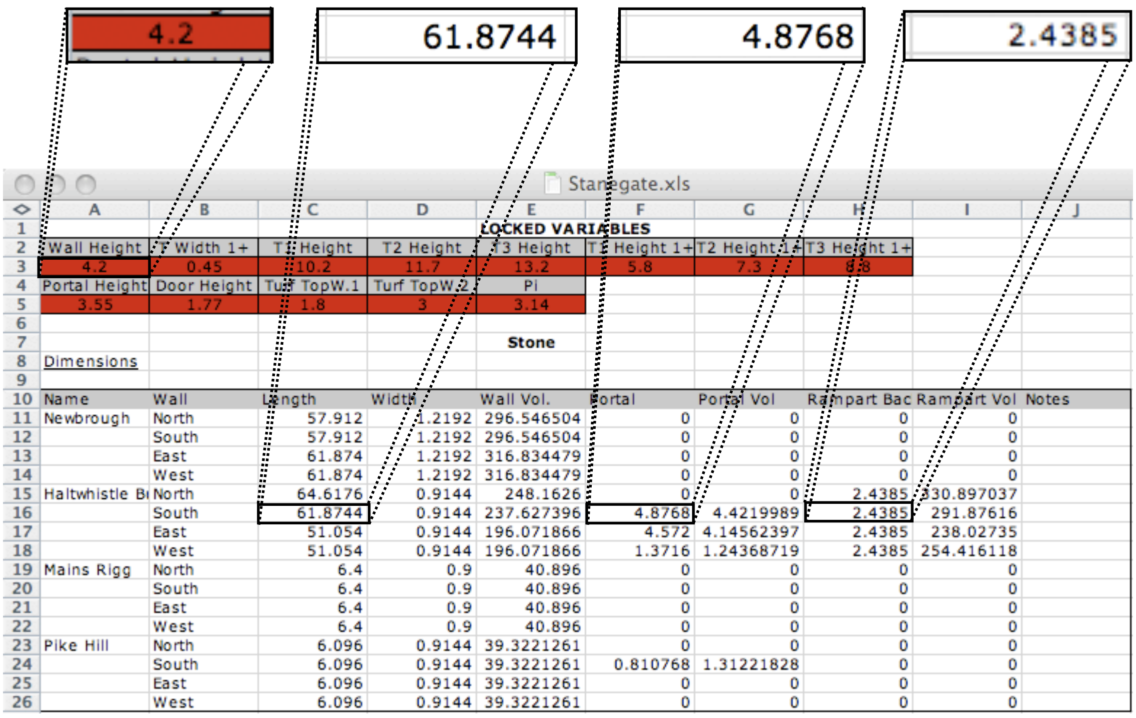
(l-r) wall width, Pi, Portal width



	A	B	C	D	E	F	G	H	I	J
1					LOCKED VARIABLES					
2	Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+		
3	4.2	0.45	10.2	11.7	13.2	5.8	7.3	8.8		
4	Portal Height	Door Height	Turf TopW.1	Turf TopW.2	Pi					
5	3.55	1.77	1.8	3	3.14					
6										
7					Stone					
8	Dimensions									
9										
10	Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol	Rampart Bac	Rampart Vol	Notes
11	Newbrough	North	57.912	1.2192	296.546504	0	0	0	0	
12		South	57.912	1.2192	296.546504	0	0	0	0	
13		East	61.874	1.2192	316.834479	0	0	0	0	
14		West	61.874	1.2192	316.834479	0	0	0	0	
15	Haltwhistle B	North	64.6176	0.9144	248.1626	0	0	2.4385	330.897037	
16		South	61.8744	0.9144	237.627396	4.8768	4.4219989	2.4385	291.87616	
17		East	51.054	0.9144	196.071866	4.572	4.14562397	2.4385	238.02735	
18		West	51.054	0.9144	196.071866	1.3716	1.24368719	2.4385	254.416118	
19	Mains Rigg	North	6.4	0.9	40.896	0	0	0	0	
20		South	6.4	0.9	40.896	0	0	0	0	
21		East	6.4	0.9	40.896	0	0	0	0	
22		West	6.4	0.9	40.896	0	0	0	0	
23	Pike Hill	North	6.096	0.9144	39.3221261	0	0	0	0	
24		South	6.096	0.9144	39.3221261	0.810768	1.31221828	0	0	
25		East	6.096	0.9144	39.3221261	0	0	0	0	
26		West	6.096	0.9144	39.3221261	0	0	0	0	

Fig. A1.6: Rampart Backing Volume

(l-r) wall height, wall length, portal width, rampart backing length



	A	B	C	D	E	F	G	H	I	J
1					LOCKED VARIABLES					
2	Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+		
3	4.2	0.45	10.2	11.7	13.2	5.8	7.3	8.8		
4	Portal Height	Door Height	Turf TopW.1	Turf TopW.2	Pi					
5	3.55	1.77	1.8	3	3.14					
6										
7					Stone					
8	Dimensions									
9										
10	Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol	Rampart Bac	Rampart Vol	Notes
11	Newbrough	North	57.912	1.2192	296.546504	0	0	0	0	
12		South	57.912	1.2192	296.546504	0	0	0	0	
13		East	61.874	1.2192	316.834479	0	0	0	0	
14		West	61.874	1.2192	316.834479	0	0	0	0	
15	Haltwhistle B	North	64.6176	0.9144	248.1626	0	0	2.4385	330.897037	
16		South	61.8744	0.9144	237.627396	4.8768	4.4219989	2.4385	291.87616	
17		East	51.054	0.9144	196.071866	4.572	4.14562397	2.4385	238.02735	
18		West	51.054	0.9144	196.071866	1.3716	1.24368719	2.4385	254.416118	
19	Mains Rigg	North	6.4	0.9	40.896	0	0	0	0	
20		South	6.4	0.9	40.896	0	0	0	0	
21		East	6.4	0.9	40.896	0	0	0	0	
22		West	6.4	0.9	40.896	0	0	0	0	
23	Pike Hill	North	6.096	0.9144	39.3221261	0	0	0	0	
24		South	6.096	0.9144	39.3221261	0.810768	1.31221828	0	0	
25		East	6.096	0.9144	39.3221261	0	0	0	0	
26		West	6.096	0.9144	39.3221261	0	0	0	0	

Step 4 is to calculate the volume contained within the area above the gateway, between the Pivot and the floor joist.[6] The variables used for this calculation are shown on Fig. A1.7.

Fig. A1.7: Pivot-Floor Joist Gateway Area
(l-r) length of opening, height of area, wall width

4.8768 0.61 0.9144

Name	Length	Height	Width	Total Vol.
Newbrough	0	0.61	1.2192	0
HWB South	4.8768	0.61	0.9144	2.72020101
HWB East	4.572	0.61	0.9144	2.55018845
HWB West	1.3716	0.61	0.9144	0.76505653

The result of these processes for all four sides provide *Step 5*, an estimate of the total volume of stone and turf contained within Halwhistle Burn's walls and rampart backing. Fig. A1.8 shows the total volumes of both materials.

Fig. A1.8: Total Stone and Turf Volume
(l-r) stone volume, turf volume

868.122418 1115.21666

Total Volume		
Name	Stone Volume	Turf Volume
Newbrough	1226.76197	0
Haltwhistle Bu	868.122418	1115.21666
Mains Rigg	163.584	0
Pike Hill	155.976286	0

These figures are then used in calculating *Step 6*, the labour requirement needed to complete the structure. The total labour demand for the stonework is calculated through the variables shown on Fig. A1.9.[7]

[6] For more information on this area, including formulae, see §4.4, Figs 4.3-4.
[7] For variable values and the reason for selection, see §4.8.4.

Fig. A1.9: Stone Labour Demand
(top row, l-r) stone volume, low quality building, shaping
(lower row, l-r) high haulage, low quality mortared work, scaffold

868.122418 | 78.6518911 | 593.578703
347.248967 | 1899.45185 | 62.0087441

Workrates

Name	Vol	Haulage Low	High	Building Low	High	Mortar Low	High	Shaping	Scaffold
Newbrough	1226.76197	1635.68262	490.704786	111.144634	222.289268	2684.15518	5368.31036	838.798494	87.6258547
Haltwhistle Bu	868.122418	1157.49656	347.248967	78.6518911	157.303782	1899.45185	3798.9037	593.578703	62.0087441
Mains Rigg	163.584	218.112	65.4336	14.8207104	29.6414208	357.921792	715.843584	111.85056	11.6845714
Pike Hill	155.976286	207.968381	62.3905144	14.1314515	28.262903	341.276114	682.552228	106.648786	11.1411633

The total labour demand for the turf aspects is shown on Fig. A1.10.[8] Taken in aggregate with the stone labour demand gives the total work rate required to construct the fort's wall.

Fig. A1.10: Turf Labour Demand
(top row, l-r) turf volume, turf cutting rate, turf laying rate
(lower rot, l-r) number of turves, turf haulage rate

1115.21666 | 1267.29166 | 1267.29166
55760.8332 | 257.722468

Name	Vol	Turf Num	Turf Cutting	Haulage	Laying	Total Person Days
Newbrough	0	0	0	0	0	0
Haltwhistle Bu	1115.21666	55760.8332	1267.29166	257.722468	1267.29166	2792.3058
Mains Rigg	0	0	0	0	0	0
Pike Hill	0	0	0	0	0	0

In the case of forts, *Step 7* is the inflation of the total labour demand of the walls to represent the whole fort.[9] These value are shown on Fig. A1.11.

Fig. A1.11: 'Inchtuthil Ratio' Inflation
(l-r) labour demand of walls, inflated labour demand of fort

5773.24595 | 20379.8527

Name	Prob Total
Newbrough	4212.42895
Haltwhistle Bu	5773.24595
Mains Rigg	561.711234
Pike Hill	535.588029

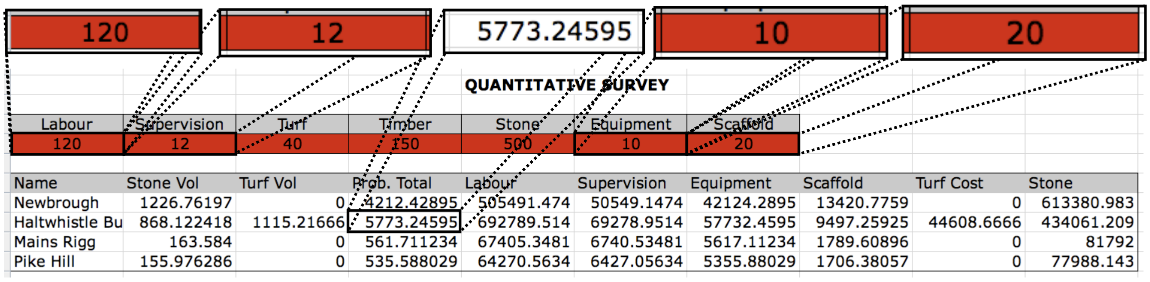
Inchtuthil Ratio Total

Name	Prob Total
Newbrough	24853.3308
Haltwhistle Bu	20379.8527

[8] For values of these variables see §4.8.5.
[9] See §4.11 for discussion on this inflation.

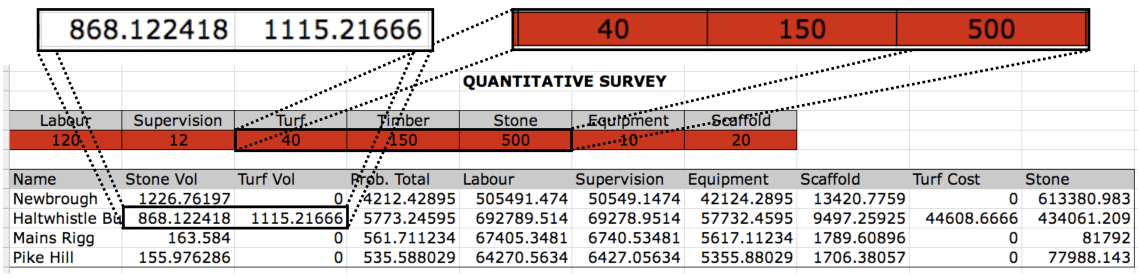
Step 8 is the calculation of the cost of each structure. This is similar to Step 1's use of variables for the calculation of volumes, in this case the variables are costs for the seven key aspects of a structure.[10] As with Step 1, referring back to locked variables means that inflation or alternative values can be easily accommodated within this responsive model. Each of the key aspects connects either to the volume of materials or the labour demand for the structure. The costs connected to labour can be seen on Fig. A1.12.

Fig. A1.12: Labour Costs
(l-r) labour per day, supervision per day, labour demand in days, equipment cost per day, scaffold cost per day



Costs connected to materials can be seen on Fig. A1.13, the combination of these with the labour results creates the total cost of the structure.

Fig. A1.13: Materials Costs
(l-r) volume of stone, volume of turf, cost of turf, cost of timber, cost of stone



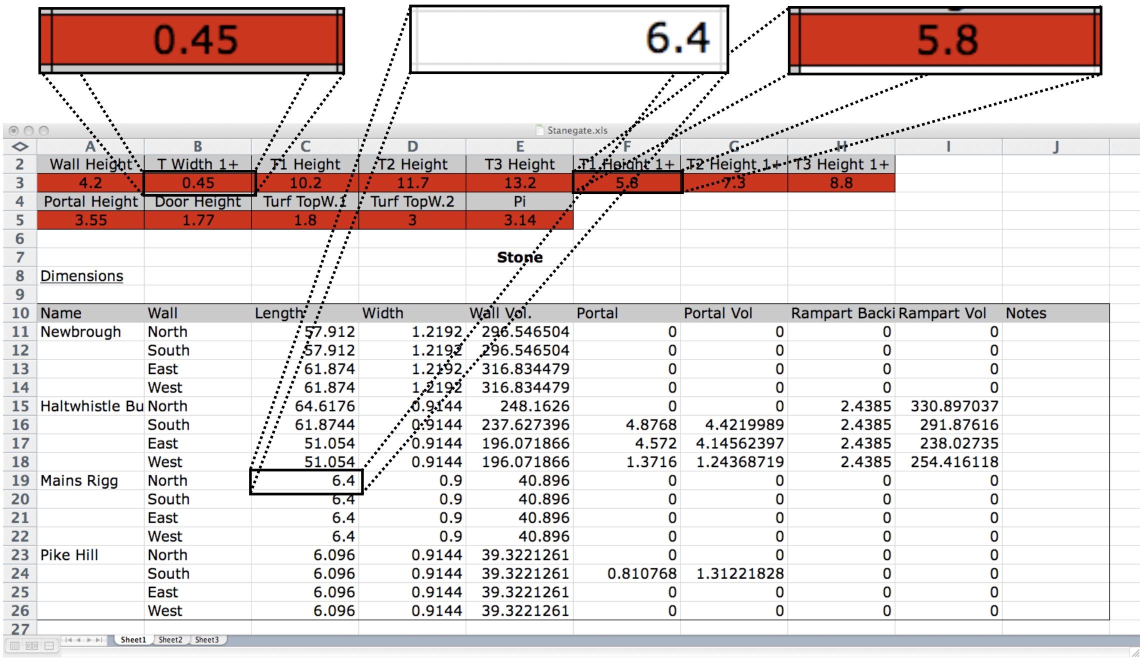
§ A1.2.1 | Turrets

As can be seen on Fig. A1.1 and Table A1.1, the height and wall width variables for stone turrets differ from those used for both forts and milecastles. Consequently, the steps involved in calculating wall

[10] For discussion of these costs see §4.12.

volumes differs to include these variables. This requires an extra calculation in *Step 1* to include the wall volume of the first and second floors.[11] The variables required for the extra calculation can be seen on Fig. A1.14.

Fig. A1.14: Turret Volume Calculations
(l-r) upper floors wall width, wall length, upper floors wall height



	A	B	C	D	E	F	G	H	I	J
2	Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+		
3	4.2	0.45	10.2	11.7	13.2	5.8	7.3	8.8		
4	Portal Height	Door Height	Turf TopW.1	Turf TopW.2	Pi					
5	3.55	1.77	1.8	3	3.14					
6										
7					Stone					
8	Dimensions									
9										

10	Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol	Rampart Backi	Rampart Vol	Notes
11	Newbrough	North	57.912	1.2192	296.546504	0	0	0	0	
12		South	57.912	1.2192	296.546504	0	0	0	0	
13		East	61.874	1.2192	316.834479	0	0	0	0	
14		West	61.874	1.2192	316.834479	0	0	0	0	
15	Haltwhistle Bu	North	64.6176	0.9144	248.1626	0	0	2.4385	330.897037	
16		South	61.8744	0.9144	237.627396	4.8768	4.4219989	2.4385	291.87616	
17		East	51.054	0.9144	196.071866	4.572	4.14562397	2.4385	238.02735	
18		West	51.054	0.9144	196.071866	1.3716	1.24368719	2.4385	254.416118	
19	Mains Rigg	North	6.4	0.9	40.896	0	0	0	0	
20		South	6.4	0.9	40.896	0	0	0	0	
21		East	6.4	0.9	40.896	0	0	0	0	
22		West	6.4	0.9	40.896	0	0	0	0	
23	Pike Hill	North	6.096	0.9144	39.3221261	0	0	0	0	
24		South	6.096	0.9144	39.3221261	0.810768	1.31221828	0	0	
25		East	6.096	0.9144	39.3221261	0	0	0	0	
26		West	6.096	0.9144	39.3221261	0	0	0	0	
27										

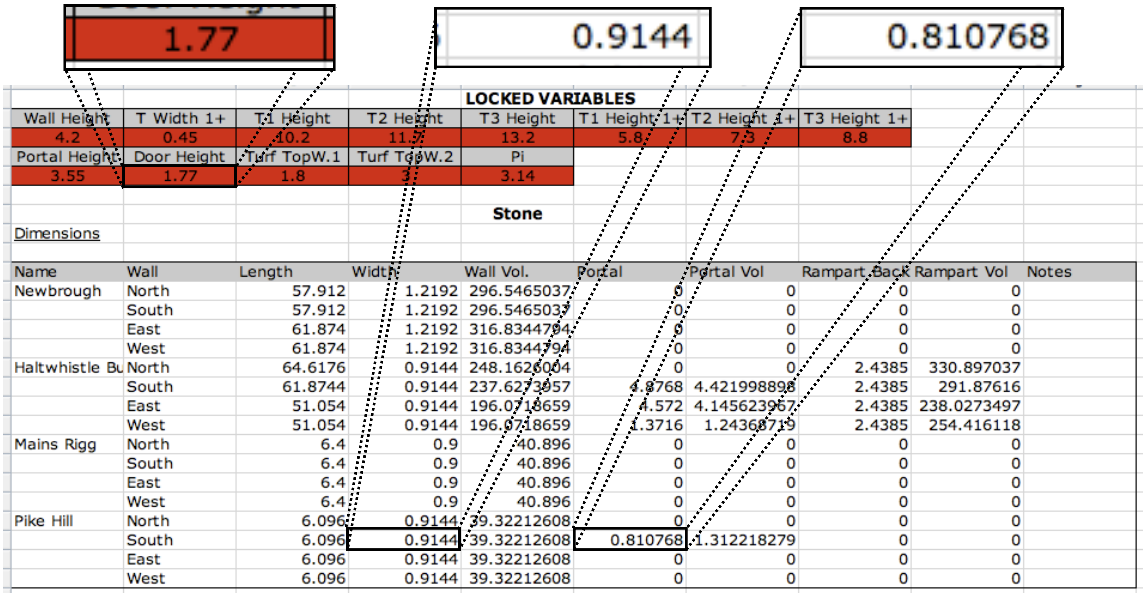
Sheet1 Sheet2 Sheet3

Turrets also possess doorways, which are calculated differently from milecastle and fort gateways.[12] The variables used for these are shown on Fig. A1.15.

[11] Turret height and wall width is discussed in §4.5.2-3.

[12] For doorway process and values see §4.4.

Fig. A1.15: Doorway Volume Calculations
(l-r) door height, wall width, length of opening



				LOCKED VARIABLES			
Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+
4.2	0.45	10.2	11.7	13.2	5.8	7.3	8.8
Portal Height	Door Height	Turf TopW.1	Turf TopW.2	Pi			
3.55	1.77	1.8	3	3.14			

Stone

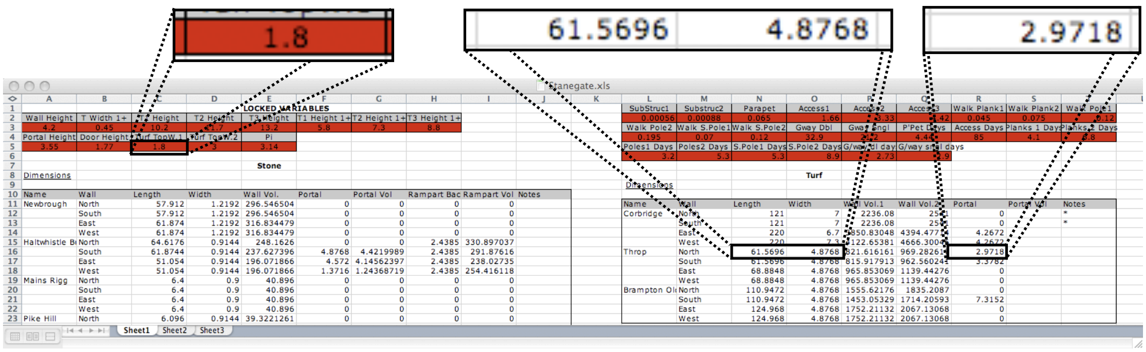
Dimensions

Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol	Rampart Back	Rampart Vol	Notes
Newbrough	North	57.912	1.2192	296.5465037	0	0	0	0	
	South	57.912	1.2192	296.5465037	0	0	0	0	
	East	61.874	1.2192	316.8344794	0	0	0	0	
	West	61.874	1.2192	316.8344794	0	0	0	0	
Haltwhistle Bu	North	64.6176	0.9144	248.1626004	0	0	2.4385	330.897037	
	South	61.8744	0.9144	237.6273957	4.8768	4.421998898	2.4385	291.87616	
	East	51.054	0.9144	196.0718659	4.572	4.145623967	2.4385	238.0273497	
	West	51.054	0.9144	196.0718659	1.3716	1.24368719	2.4385	254.416118	
Mains Rigg	North	6.4	0.9	40.896	0	0	0	0	
	South	6.4	0.9	40.896	0	0	0	0	
	East	6.4	0.9	40.896	0	0	0	0	
	West	6.4	0.9	40.896	0	0	0	0	
Pike Hill	North	6.096	0.9144	39.32212608	0	0	0	0	
	South	6.096	0.9144	39.32212608	0.810768	1.312218279	0	0	
	East	6.096	0.9144	39.32212608	0	0	0	0	
	West	6.096	0.9144	39.32212608	0	0	0	0	

§ A1.3 | Turf and Timber Structures

Due to their different shapes and constitution, turf and timber structures require an alternate process in order to be quantified. Due to the many unknowns of turf structures, thanks in part to their poor archaeological visibility, a comparative approach is taken regarding the ramparts form. This leads to two separate estimations for the wall volumes of the structures,[13] though this walkthrough will only look at Type 1 structures. The variables for which are shown on Fig. A1.16, which are used in *Step 1*.

Fig. A1.16: Turf Rampart Calculations
(l-r) type 1 top width, type 2 top width, rampart length, rampart width, portal length



[13] Discussion on these values can be found in §4.6.1.

Step 2 sees the combination of the separate wall volumes into the total turf volume for the structure. This figure is then converted into the number of Vegetian standard turves which comprise the ramparts. This can be seen on Fig. A1.17.

Fig. A1.17: Rampart Volume and Total Number of Turves
(l-r) type 1 rampart volume, number of turves for type 1 rampart

3569.24021 118974.674

Volume				
Name	Vol 1	Vol 2	Num Turf 1	Num Turf 2
Corbridge	12445.6443	14142.7776	414854.81	471425.92
Throp	3569.24021	4210.72839	118974.674	140357.613
Brampton Old	6513.09768	7683.67599	217103.256	256122.533

Step 3 sees the estimates for the amount of wood needed for the turf rampart's. There are alternatives presented for the different aspects of a rampart, from the timber needed in the substructure to the amount needed on the rampart walk, which allows the model to adapt to different interpretations.[14] The variables used for timber calculations are shown on Fig. A1.18.

[14] For the values, and their reasons for selection, see §4.7.

Fig. A1.18: Timber Volume Calculations
(top row l-r) timber per m3 of turf in substructure, timber per m in parapet, length of ramparts, timber volume per access
(lower row, l-r) timber per m in rampart walk, volume of ramparts, timber volume per gateway

0.00056 | 0.07 | 0.065 | 3.33 | 21.2

SubStruc1	Substruc2	Parapet	Access1	Access2	Access3	Walk Plank1	Walk Plank2	Walk Pole1
0.00056	0.00088	0.065	1.66	3.33	4.42	0.045	0.075	0.12
Walk Pole2	Walk S.Pole1	Walk S.Pole2	Gway Dbl	Gway Sngl	P'Pet Days	Access Days	Planks 1 Days	Planks 2 Days
0.195	0.07	0.12	32.9	21.2	4.44	85	4.1	6.8
Poles1 Days	Poles2 Days	S.Pole1 Days	S.Pole2 Days	G/way dl days	G/way sngl days			
3.2	5.3	5.3	8.9	2.73	2.9			

Turf

Dimensions

Name	Wall	Length	Width	Wall Vol.1	Wall Vol.2	Portal	Portal Vol	Notes
Corbridge	North	121	7	2236.08	2541	0		*
	South	121	7	2236.08	2541	0		*
	East	220	6.7	3850.83048	4394.47714	4.2672		
	West	220	7.3	4122.65381	4666.30046	4.2672		
Throp	North	61.5696	4.8768	821.616161	969.282617	2.9718		
	South	61.5696	4.8768	815.917913	962.560241	3.3782		
	East	68.8848	4.8768	965.853069	1139.44276	0		
	West	68.8848	4.8768	965.853069	1139.44276	0		
Brampton Old	North	110.9472	4.8768	1555.62176	1835.2087	0		
	South	110.9472	4.8768	1453.05329	1714.20593	7.3152		
	East	124.968	4.8768	1752.21132	2067.13068	0		
	West	124.968	4.8768	1752.21132	2067.13068	0		

*=Wall width avg. of E & W

Volume

Name	Vol 1	Vol 2	Num Turf 1	Num Turf 2
Corbridge	12445.6443	14142.7776	414854.81	471425.92
Throp	3569.24021	4210.72839	118974.674	140357.613
Brampton Old	6513.09768	7683.67599	217103.256	256122.533

3569.24021

61.5696
61.5696
68.8848
68.8848

With the volumes of both turf and timber calculated, *Step 4* considers the labour demands. This takes the volume of turf and number of turves and calculates how long they would have taken to complete.[15] These variables can be seen on Fig. A1.19.

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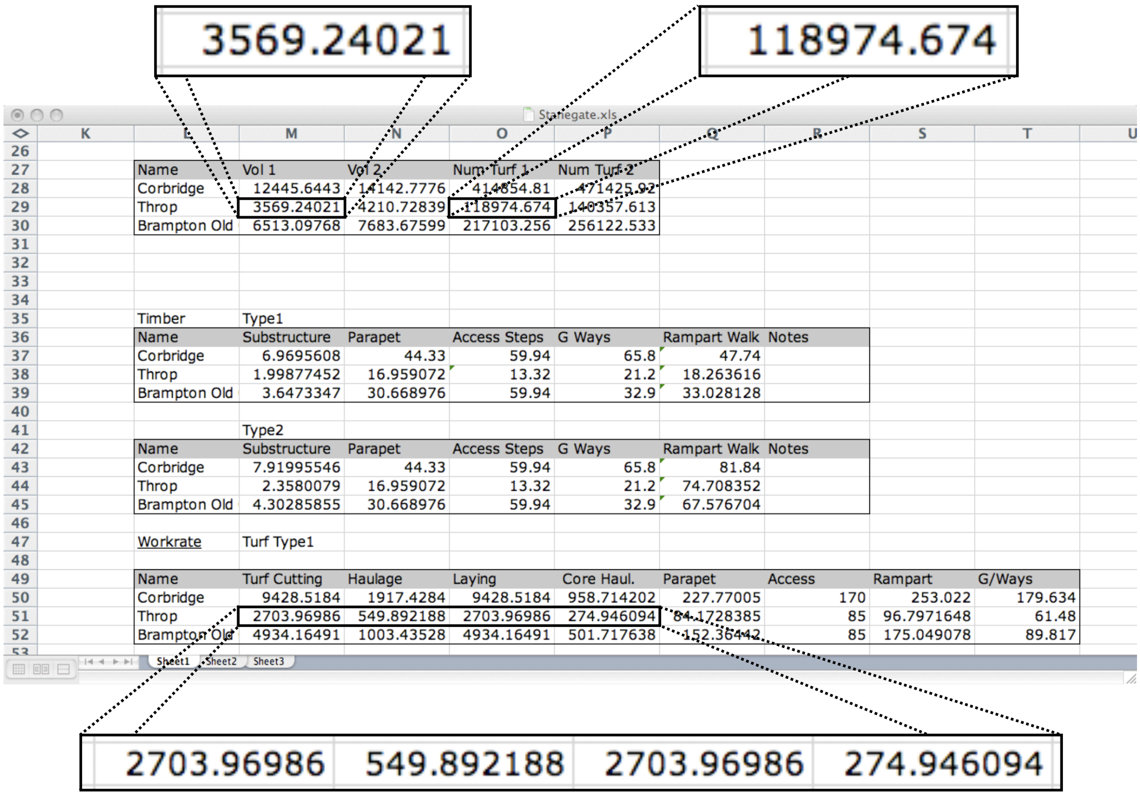
[15] The processes and the rate of completion are discussed in §4.8.5.

Fig. A1.19: Turf Labour Requirement

(top row, l-r) turf volume, number of turves

(lower row, l-r) turf cutting rate, turf haulage rate, turf laying rate, core haulage rate

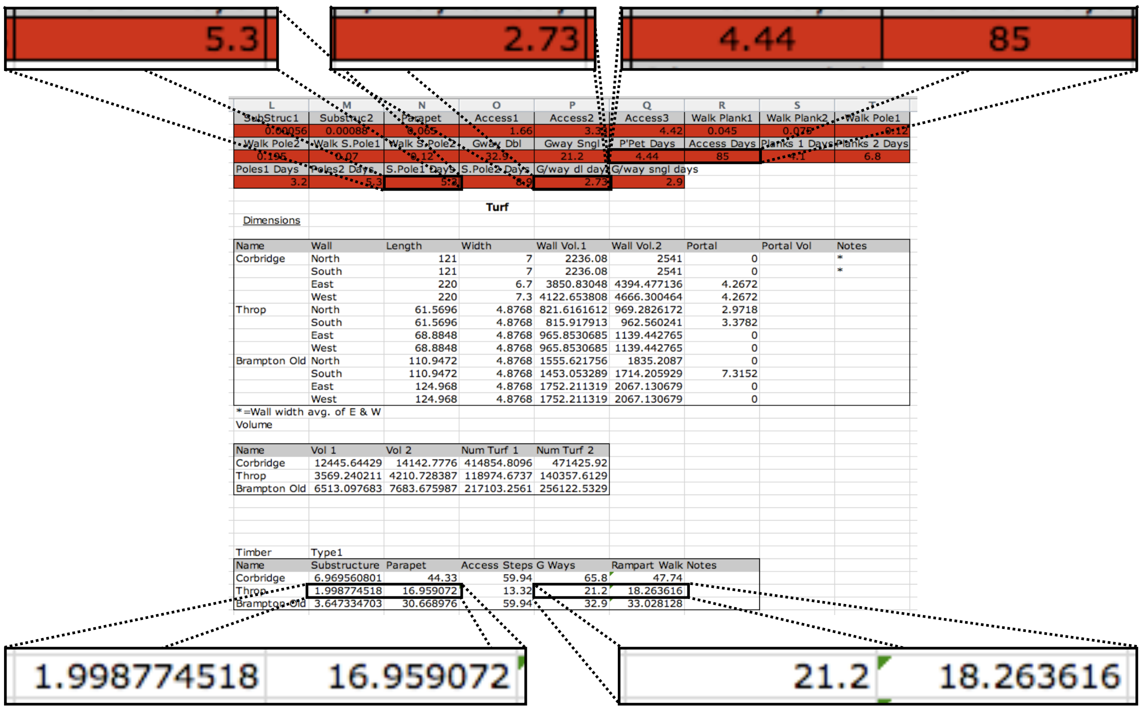


Furthermore, the timber volume is used to estimate how long the timber sections of the structure would take to complete. Timber variables can be seen on Fig. A1.20.

Fig. A1.20: Timber Labour Requirement

(top row, l-r) days per m^3 split pole type 1, days per m^3 gateway, days per m^3 parapet, days per access way

(lower row, l-r) substructure volume, parapet volume, gateway volume, rampart walk volume



With all materials volumes and workrate estimations complete, the cost of the structure, *Step 6*, can then be calculated. This is identical to the process for stone structures, with only the materials, timber rather than stone, changing. This difference can be seen in Fig. A1.21, which can be contrasted with Fig. A.1.13.

Fig. A1.21: Turf and Timber Materials Cost
(l-r) turf volume, timber volume, turf cost, timber cost, stone cost

3569.240211	71.74146252

40	150	500

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
Corbridge 1	12445.64429	224.7795608	22563.60546	2707632.655	270763.2655	225636.0546	497825.7715	33716.93412
Corbridge 2	14142.7776	259.8299555	26006.79458	3120815.35	312081.535	260067.9458	565711.104	38974.49332
Throp 1	3569.240211	71.74146252	6560.227999	787227.3599	78722.73599	65602.27999	142769.6085	10761.21938
Throp 2	4210.728387	53.8370799	8250.127502	990015.3003	99001.53003	82501.27502	168429.1355	8075.561985
BOC 1	6513.097683	160.1844387	11875.71323	1425085.588	142508.5588	118757.1323	260523.9073	24027.66581
BOC 2	7683.675987	195.3885386	14349.12718	1721895.261	172189.5261	143491.2718	307347.0395	29308.28078

§ A1.4 | Stanegate Data

The data gathered to generate these quantitative results for the Stanegate can be seen overleaf. The predominantly stone structures are presented first, followed by the turf and timber structures. The sources used to compile the quantitative survey are listed on Table A1.3.

Table A1.3	
Site	**Sources Used**
Newbrough	Birley, 1961.
Haltwhistle Burn	Simpson & Gibson, 1909.
Mains Rigg	Hassall, Wilson & Wright, 1972.
Pike Hill	Simpson & McIntyre, 1933.
Corbridge	Bishop & Dore, 1989.
Throp	Simpson, 1913.
Brampton Old Church	Simpson & Richmond, 1936.

Table A1.3: Sources used in compiling quantitative survey.

§ A1.4.1 | Stone Volumes

LOCKED VARIABLES

Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+
4.2	0.45	10.2	11.7	13.2	5.8	7.3	8.8
Portal Height	Door Height	Turf TopW.1	Turf TopW.2	Pi			
3.55	1.77	1.8	3	3.14			

Stone

Dimensions

Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol	Rampart Back	Rampart Vol	Notes
Newbrough	North	57.912	1.2192	296.5465037	0	0	0	0	
	South	57.912	1.2192	296.5465037	0	0	0	0	
	East	61.874	1.2192	316.8344794	0	0	0	0	
	West	61.874	1.2192	316.8344794	0	0	0	0	
Haltwhistle Bu	North	64.6176	0.9144	248.1626004	0	0	2.4385	330.897037	
	South	61.8744	0.9144	237.6273957	4.8768	4.421998898	2.4385	291.87616	
	East	51.054	0.9144	196.0718659	4.572	4.145623967	2.4385	238.0273497	
	West	51.054	0.9144	196.0718659	1.3716	1.24368719	2.4385	254.416118	
Mains Rigg	North	6.4	0.9	40.896	0	0	0	0	
	South	6.4	0.9	40.896	0	0	0	0	
	East	6.4	0.9	40.896	0	0	0	0	
	West	6.4	0.9	40.896	0	0	0	0	
Pike Hill	North	6.096	0.9144	39.32212608	0	0	0	0	
	South	6.096	0.9144	39.32212608	0.810768	1.312218279	0	0	
	East	6.096	0.9144	39.32212608	0	0	0	0	
	West	6.096	0.9144	39.32212608	0	0	0	0	

Pivot-Floor Joist — Source: AA5,20, 46-9.

Name	Length	Height	Width	Total Vol.
Newbrough	0	0.61	1.2192	0
HWB South	4.8768	0.61	0.9144	2.720201011
HWB East	4.572	0.61	0.9144	2.550188448
HWB West	1.3716	0.61	0.9144	0.765056534

Total Volume

Name	Stone Volume	Turf Volume
Newbrough	1226.761966	0
Haltwhistle Bu	868.1224179	1115.216665
Mains Rigg	163.584	0
Pike Hill	155.976286	0

§ A1.4.2 | Stone Labour and Quantitative Survey

Workrates

		Haulage		Building		Mortar			
Name	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold
Newbrough	1226.761966	1635.682621	490.7047864	111.1446341	222.2892683	2684.155182	5368.310364	838.7984943	87.62585472
Haltwhistle Bu	868.1224179	1157.496557	347.2489672	78.65189107	157.3037821	1899.45185	3798.903701	593.5787033	62.00874414
Mains Rigg	163.584	218.112	65.4336	14.8207104	29.6414208	357.921792	715.843584	111.85056	11.68457143
Pike Hill	155.976286	207.9683814	62.39051442	14.13145152	28.26290303	341.2761139	682.5522277	106.6487856	11.14116329

Name	Vol	Turf Num	Turf Cutting	Haulage	Laying	Total Person Days
Newbrough	0	0	0	0	0	0
Haltwhistle Bu	1115.216665	55760.83323	1267.291664	257.7224683	1267.291664	2792.305797
Mains Rigg	0	0	0	0	0	0
Pike Hill	0	0	0	0	0	0

Name	Prob Total
Newbrough	4212.428951
Haltwhistle Bu	5773.245953
Mains Rigg	561.7112338
Pike Hill	535.5880287

Inchtuthil Ratio Total

Name	Prob Total
Newbrough	24853.33081
Haltwhistle Bu	20379.85272

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name	Stone Vol	Turf Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Turf Cost	Stone
Newbrough	1226.761966	0	4212.428951	505491.4742	50549.14742	42124.28951	13420.77591	0	613380.983
Haltwhistle Bu	868.1224179	1115.216665	5773.245953	692789.5144	69278.95144	57732.45953	9497.259252	44608.66659	434061.209
Mains Rigg	163.584	0	561.7112338	67405.34806	6740.534806	5617.112338	1789.60896	0	81792
Pike Hill	155.976286	0	535.5880287	64270.56344	6427.056344	5355.880287	1706.380569	0	77988.14302

Name	Cost in £'s	Construc. Units
Newbrough	1224966.67	122496.667
Haltwhistle Bu	1307968.06	130796.806
Mains Rigg	163344.6042	16334.46042
Pike Hill	155748.0237	15574.80237

§ A1.4.3 | Turf Volumes

SubStruc1	Substruc2	Parapet	Access1	Access2	Access3	Walk Plank1	Walk Plank2	Walk Pole1
0.00056	0.00088	0.065	1.66	3.33	4.42	0.045	0.075	0.12
Walk Pole2	Walk S.Pole1	Walk S.Pole2	Gway Dbl	Gway Sngl	P'Pet Days	Access Days	Planks 1 Days	Planks 2 Days
0.195	0.07	0.12	32.9	21.2	4.44	85	4.1	6.8
Poles1 Days	Poles2 Days	S.Pole1 Days	S.Pole2 Days	G/way dl days	G/way sngl days			
3.2	5.3	5.3	8.9	2.73	2.9			

Turf

Dimensions

Name	Wall	Length	Width	Wall Vol.1	Wall Vol.2	Portal	Portal Vol	Notes
Corbridge	North	121	7	2236.08	2541	0		*
	South	121	7	2236.08	2541	0		*
	East	220	6.7	3850.83048	4394.477136	4.2672		
	West	220	7.3	4122.653808	4666.300464	4.2672		
Throp	North	61.5696	4.8768	821.6161612	969.2826172	2.9718		
	South	61.5696	4.8768	815.917913	962.560241	3.3782		
	East	68.8848	4.8768	965.8530685	1139.442765	0		
	West	68.8848	4.8768	965.8530685	1139.442765	0		
Brampton Old	North	110.9472	4.8768	1555.621756	1835.2087	0		
	South	110.9472	4.8768	1453.053289	1714.205929	7.3152		
	East	124.968	4.8768	1752.211319	2067.130679	0		
	West	124.968	4.8768	1752.211319	2067.130679	0		

*=Wall width avg. of E & W

Volume

Name	Vol 1	Vol 2	Num Turf 1	Num Turf 2
Corbridge	12445.64429	14142.7776	414854.8096	471425.92
Throp	3569.240211	4210.728387	118974.6737	140357.6129
Brampton Old	6513.097683	7683.675987	217103.2561	256122.5329

§ A1.4.4 | Timber Volumes and Labour

Timber — Type1

Name	Substructure	Parapet	Access Steps	G Ways	Rampart Walk	Notes
Corbridge	6.969560801	44.33	59.94	65.8	47.74	
Throp	1.998774518	16.959072	13.32	21.2	18.263616	
Brampton Old	3.647334703	30.668976	59.94	32.9	33.028128	

Type2

Name	Substructure	Parapet	Access Steps	G Ways	Rampart Walk	Notes
Corbridge	7.919955456	44.33	59.94	65.8	81.84	
Throp	2.358007897	16.959072	13.32	21.2	74.708352	
Brampton Old	4.302858553	30.668976	59.94	32.9	67.576704	

Workrate — Turf Type1

Name	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways
Corbridge	9428.5184	1917.428405	9428.5184	958.7142023	227.77005	170	253.022	179.634
Throp	2703.969857	549.8921876	2703.969857	274.9460938	84.17283854	85	96.7971648	61.48
Brampton Old	4934.164912	1003.435275	4934.164912	501.7176375	152.3644195	85	175.0490784	89.817

Turf Type2

Name	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways
Corbridge	10714.22545	2178.895914	10714.22545	1089.447957	231.9898022	170	728.376	179.634
Throp	3189.945748	648.7225592	3189.945748	324.3612796	85.76783474	85	664.9043328	61.48
Brampton Old	5820.966657	1183.779501	5820.966657	591.8897507	155.2749454	85	601.4326656	89.817

Name	Typ1 TPD	Typ2 TPD
Corbridge	22563.60546	26006.79458
Throp	6560.227999	8250.127502
Brampton Old	11875.71323	14349.12718

§ A1.4.5 | Turf and Timber Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
Corbridge 1	12445.64429	224.7795608	22563.60546	2707632.655	270763.2655	225636.0546	497825.7715	33716.93412
Corbridge 2	14142.7776	259.8299555	26006.79458	3120815.35	312081.535	260067.9458	565711.104	38974.49332
Throp 1	3569.240211	71.74146252	6560.227999	787227.3599	78722.73599	65602.27999	142769.6085	10761.21938
Throp 2	4210.728387	53.8370799	8250.127502	990015.3003	99001.53003	82501.27502	168429.1355	8075.561985
BOC 1	6513.097683	160.1844387	11875.71323	1425085.588	142508.5588	118757.1323	260523.9073	24027.66581
BOC 2	7683.675987	195.3885386	14349.12718	1721895.261	172189.5261	143491.2718	307347.0395	29308.28078

Name	Total Cost	Construc Units
Corbridge 1	3735574.68	373557.468
Corbridge 2	4297650.428	429765.0428
Throp 1	1085083.204	108508.3204
Throp 2	1348022.803	134802.2803
BOC 1	1970902.852	197090.2852
BOC 2	2374231.379	237423.1379

Inchtuhil Ratio

Name	Total Pers Days
Corbridge 1	133125.2722
Corbridge 2	153440.088
Throp 1	38705.34519
Throp 2	48675.75226
BOC 1	70066.70808
BOC 2	84659.85035

Appendix 2 | Hadrian's Wall

§ A2.1 | Introduction

This is the data appendix for Hadrian's Wall containing all the quantitative survey for the structures of the Wall and the linear barriers of curtain, ditch and vallum. The linear features will be dealt with first, followed by the structures of turret, milecastles and forts. The sources used in compiling the survey are shown on Table A2.1.

Table A2.1		
Site	Sources Used	Notes
Curtain: Segedunum - Newcastle	Birley, 1961.	
Curtain: Wall Mile 4 - 22	Birley, 1961.	
Curtain: Wall Mile 22 - 27 (1)	Birley, 1961.	
Curtain: Wall Mile 22 - 27 (2)	Birley, 1961.	
Curtain: Wall Mile 27 - T45a	Birley, 1961.	
Curtain: Wall Mile 48	Birley, 1961.	
Curtain: T45a - River Irthing	Birley, 1961.	Excludes Wall Mile 48
Curtain: Wall Miles 49 - 54	Birley, 1961.	
Curtain: Wall Miles 54 - 80	Birley, 1961.	
Curtain: Turf Wall	Birley, 1961.	6m assumed as rampart width.
Ditch: Newcastle - Benwell	Spain, 1934.	
Ditch: Benwell - Rudchester	Jobey, 1958.	

Table A2.1		
Ditch: East of Heddon	Daniels, 1978.	
Ditch: Stanley	Daniels, 1978.	
Ditch: Halton Chesters, east gate.	Daniels, 1978.	
Ditch: Chesters	Daniels, 1978.	
Ditch: Cockmount Hill	Daniels, 1978.	Ditch dug to half depth.
Ditch: Carvoran - Thirlwall	Daniels, 1978.	
Ditch: Thirlwall - Birdoswald	Salway, 1959.	
Ditch: Birdoswald	Daniels, 1978.	
Vallum: Newcastle - Benwell	Spain *et al*., 1930.	
Vallum: Benwell - Rudchester	Bidwell, 1996.	
Vallum: Rudchester - Halton Chesters	Bennett *et al.*, 1983.	
Vallum: Chesters - Carrawburgh	Bidwell, 1999.	
Vallum: Housesteads - Great Chesters	Haverfield, 1898; Simpson, 1976.	
Vallum: Great Chesters - Carvoran	Wright, 1940.	
Vallum: Carvoran - Birdoswald	Haverfield, 1898.	
Vallum: Birdoswald	Haverfield, 1898.	
Vallum: Birdoswald - Castlesteads	Simpson *et al*., 1936.	
Vallum: Castlesteads	Haverfield, 1898.	
Vallum: Castlesteads - Stanwix	Haverfield, 1895.	
Vallum: Drumburgh - Bowness	Simpson *et al*., 1935.	
T7b	Birley, 1930.	
T10a	Bennett, 1983.	
T12a	Simpson, 1931.	
T12b	Simpson, 1931.	
T13a	Simpson, 1931.	
T17a	Birley *et al*, 1932.	South wall presumed.
T17b	Birley *et al*, 1932.	Only south wall survives.

Table A2.1		
T18a	Brewis, 1932.	
T18b	Woodfield, 1965.	North extent conjectural.
T19a	Birley *et al*, 1933.	South wall width as east and west.
T19b	Birley *et al*, 1933.	
T25b	Woodfield, 1965.	
T26a	Woodfield, 1965.	East wall width as west.
T26b	Breeze, 2006b.	
T29a	Clayton, 1876; Charlesworth, 1973a.	
T29b	Newbold, 1913.	
T33b	Miket & Maxfield, 1972.	
T34a	Charlesworth, 1973a.	
T35a	Woodfield, 1965.	
T39a	Simpson, 1976.	
T39b	Simpson, 1976.	
T41a	Charlesworth, 1968.	North extent conjectural.
T44b	Newbold, 1913.	
T45a	Woodfield, 1965.	Doorway conjectural.
T45b	Newbold, 1913.	
T48a	Shaw, 1926.	
T48b	Shaw, 1926; *id*., 1927.	South wall presumed.
T50a	Simpson *et al*., 1935.	
T50b	Simpson *et al*., 1935.	
T51a	Charlesworth, 1973b.	
T52a	Simpson & Richmond, 1934.	
T53a	Simpson & Richmond, 1933.	
T54a (Phase I)	Simpson & Richmond, 1934.	
T54a (Phase II)	Simpson & Richmond, 1934.	

Table A2.1		
T72b	Simpson *et al*., 1952.	Doorway conjectural.
T79b	Simpson *et al*., 1935.	Doorway conjectural.
MC9	Birley, 1930.	North extent conjectural.
MC10	Dodds, 1930.	
MC13	Simpson, 1931.	Portals conjectural.
MC17	Birley *et al*., 1932.	
MC18	Birley *et al*., 1932.	
MC19	Simpson *et al*., 1936.	Portals conjectural.
MC20	Simpson *et al*., 1936.	South portal presumed as north.
MC27	Gillam, 1953.	North portal presumed as south.
MC29	Birley, 1960.	Portals conjectural.
MC30	Birley, 1960.	Portals conjectural.
MC33	Simpson *et al*., 1936.	South portal presumed as north. South wall width as east and west.
MC37	Blair, 1934.	
MC38	Simpson *et al*., 1936.	
MC39	Simpson, 1976.	
MC40	Simpson, 1976.	
MC42	Simpson *et al*., 1936.	
MC47	Simpson *et al*., 1936.	North portal presumed as south.
MC48	Gibson & Simpson, 1911.	
MC49	Richmond, 1956.	
MC50 TW	Simpson et al., 1935.	
MC52	Simpson et al., 1935.	
MC53	Simpson & Richmond, 1933.	Only east wall survives.
MC54	Simpson et al., 1935.	
MC72	Austen, 1994.	South wall conjectural.
MC73	Simpson *et al*., 1952.	North wall and portals conjectural.
MC79	Richmond & Gillam, 1952.	
MC79 TW	Richmond & Gillam, 1952.	

Table A2.1		
Wallsend	Hodgson, 2003; Field investigation.	Average portal width used for west wall.
Benwell	Petch, 1927; *id*., 1928.	Portal averages used on all walls.
Rudchester	Brewis, 1925.	Portal averages used on north and south walls.
Halton Chesters	Simpson & Richmond, 1937.	Average portal width used for south wall.
Chesters	Bruce, 1880; Breeze, 2006b.	North wall portal average used. Rampart backing calculated from turrets.
Carrawburgh	Breeze, 1972.	Wall widths assumed as west wall. Average portal widths used throughout. Rampart backing average used.
Housesteads	Crow, 1988; *id*., 1995.	South and west wall rampart backing uses average of north and east.
Great Chesters	Gibson, 1903b.	Average portal widths used throughout. Rampart backing calculated from turrets.
Drumburgh (turf)	Simpson & Richmond, 1952.	
Birdoswald (stone)	Wilmott, 1997; *id*., 2001.	North portal presumed as south.
Castlesteads (stone)	Richmond & Hodgson, 1934.	North wall conjectural. West wall width used for all.
Stanwix (stone)	Simpson & Richmond, 1941; Dacre, 1985.	Average portal and rampart backing used throughout.
Bowness on Solway (stone)	Birley, 1931; Potter, 1979.	Wall widths assumed as west.

Table A2.1: Sources consulted in survey.

§ A2.2 | The Stone Curtain Wall: Volume and Labour

A	B	C	D	E	F	G	H	I	J
				LOCKED VARIABLES					
Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+	T Height G	
4	0.45	10.2	11.7	13.2	5.8	7.3	8.8	4.4	
Portal Height	Pivet-Floor H	Door Height	Turf TopW.1	Turf TopW.2	Pi	Found. Depth			
3.55	0.61	1.77	1.8	3	3.14	0.2			
Volume									
Wall Zone	Zone Length	Found Width	Super Width	Found Vol	Super Vol	Total	Notes		
Seg - Ael	5500	2.5	2.29	2750	47861	50611			
4 - 22	26770	2.97	2.86	15901.38	290936.36	306837.74			
22 - 27	3840	3.43	3	2634.24	43776	46410.24			
22 - 27	3840	3.43	1.83	2634.24	26703.36	29337.6			
N.Tyne - T45a	27160	3.15	2.21	17110.8	228089.68	245200.48			
Mile 48	1390	3.15	2.74/2.21	875.7	13072.95	13948.65			
45a - Irthing (excl. 48)	4100	3.15	2.74	2583	42689.2	45272.2			
Total:						737617.91			
Original Plan	72600	3.2	2.93	46464	808328.4	854792.4			
Workrate									
		Haulage		Building		Mortar			
Name	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold
Seg - Ael	50611	67481.3333	20244.4	4585.3566	9170.7132	110736.868	221473.736	34605.2713	3795.825
4 - 22	306837.74	409116.987	122735.096	27799.4992	55598.9985	671360.975	1342721.95	209800.305	23012.83
22 - 27	46410.24	61880.32	18564.096	4204.76774	8409.53549	101545.605	203091.21	31733.0016	3480.768
22 - 27	29337.6	39116.8	11735.04	2657.98656	5315.97312	64190.6688	128381.338	20059.584	2200.32
N.Tyne - T45a	245200.48	326933.973	98080.192	22215.1635	44430.327	536498.65	1072997.3	167655.828	18390.04
Mile 48	13948.65	18598.2	5579.46	1263.74769	2527.49538	30519.6462	61039.2924	9537.38944	1046.149
45a - Irthing (excl. 48)	45272.2	60362.9333	18108.88	4101.66132	8203.32264	99055.5736	198111.147	30954.8668	3395.415
Original Plan	854792.4	1139723.2	341916.96	77444.1914	154888.383	1870285.77	3740571.54	584464.304	64109.43

§ A2.3 | The Stone Curtain Wall: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name	Stone Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Cost in £'s	Con. Units
Seg - Ael	50611	173967.721	20876126.5	2087612.65	1739677.21	486877.82	25305500	50495794.2	5049579
4 - 22	306837.74	1054708.71	126565045	12656504.5	10547087.1	2129453.92	153418870	305316960	30531696
22 - 27	46410.24	159528.238	19143388.6	1914338.86	1595282.38	322087.066	23205120	46180216.9	4618022
22 - 27	29337.6	100843.599	12101231.9	1210123.19	1008435.99	282227.712	14668800	29270818.8	2927082
N.Tyne - T45a	245200.48	842839.87	101140784	10114078.4	8428398.7	2358828.62	122600240	244642330	24464233
Mile 48	13948.65	47946.3921	5753567.05	575356.705	479463.921	115494.822	6974325	13898207.5	1389821
45a - Irthing (excl. 48)	45272.2	155616.397	18673967.6	1867396.76	1556163.97	314189.068	22636100	45047817.4	4504782
Avrg:			43464873	4346487.3	3622072.75	858451.289	52686993.6	104978878	10497888
Total:	737617.91	2535450.92	304254111	30425411.1	25354509.2	6009159.02	368808955	734852145	73485215
Original Plan	854792.4	2938220.66	352586479	35258647.9	29382206.6	5932259.26	427396200	850555792	85055579

§ A2.4 | The Turf Curtain Wall: Volume and Labour

SubStruc1	Substruc2	Parapet	Access1	Access2	Access3	Walk Plank1	Walk Plank2	Walk Pole1
0.00056	0.00088	0.065	1.66	3.33	4.42	0.045	0.075	0.12
Walk Pole2	Walk S.Pole1	Walk S.Pole2	Gway Dbl	Gway Sngl	P'Pet Days	Access Days	Planks 1 Days	lanks 2 Days
0.195	0.07	0.12	32.9	21.2	4.44	85	4.1	6.8
Poles1 Days	Poles2 Days	S.Pole1 Days	S.Pole2 Days	G/way dl day	G/way sngl days			
3.2	5.3	5.3	8.9	2.73	2.9			

TURF

Dimensions and Volume — Turf

Zone	Length	Base Width	Vol1	Vol2	Num. Turves1	Num Turves2	Notes
All	49889.66	6	778278.696	898013.88	25942623.2	29933796	

Timber

Zone	Substruc	Parapet	Access	Rampart Wlk	Gways	Notes
All Type 1	435.83607	3242.8279	n/a	3492.2762	n/a	
All Type 2	502.887773	3242.8279	n/a	5986.7592	n/a	

Manpower and Building Time

Type 1

Zone	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Rampart Wlk
All	589605.073	119904.896	589605.073	59952.4478	16333.268	18509.06386

Type 2

Zone	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Rampart Wlk
All	680313.545	138351.803	680313.545	69175.9013	16630.9776	53282.15688

Zone	Total Person	Build. Team	Est. Time
Type 1 - All	1393909.82	3000	464.636607
Zone	Total Person	Build. Team	Est. Time
Type 2 - All	1638067.93	3000	546.022643

§ A2.5 | The Turf Curtain Wall: Quantitative Survey

Zone	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
Type 1 - All	778278.696	7170.94017	1393909.82	167269178	16726917.8	13939098.21	31131147.84	1075641
Type 2 - All	898013.88	9732.47487	1638067.93	196568152	19656815.2	16380679.29	35920555.2	1459871.2

Zone	Cost in £'s	Construc. Units
Type 1 - All	230141983.4	23014198
Type 2 - All	269986072.4	26998607

§ A2.6 | The Turf Rebuild: Stone Volume and Labour

LOCKED VARIABLES

Wall Height	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+	T Height G
4	0.45	10.2	11.7	13.2	5.8	7.3	8.8	4.4
Portal Height	Pivet-Floor H	Door Height	Av Door Wdt	Turf TopW.1	Turf TopW.2	Pi	Foundation H	
3.55	0.61	1.77	1.03	1.8	3	3.14	0.2	

STONE

Dimensions

Zone	Found. L	Found. W	Found. Vol.	SS. L	SS. W	SS. Vol	Notes
49-54	8046.72	2.59	4168.20096	8046.72	2.29	70022.5574	
54-80	41842.94	2.74	22929.9311	41842.94	2.67	424538.469	

Manpower

		Haulage		Building		Mortar			
Zone	Tot Vol	Low	High	Low	High	Low	High	Shaping	Scaffold
49-54	74190.7584	98921.0112	29676.3034	7686.16257	15372.3251	143039.782	286079.564	44699.93194	5564.3069
54-80	447468.4	596624.534	178987.36	46357.7263	92715.4526	862719.076	1725438.15	269599.7112	33560.13

Building Time

Zone	Prob. Total	Build Team	Est. Time
49-80	1621890.49	3000	540.630164

§ A2.7 | The Turf Rebuild: Stone Quantitative Survey

31					QUANTITATIVE SURVEY					
32										
33	Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold			
34	120	12	40	150	500	10	20			
35										
36	Zone	Stone Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Cost in £'s	Construc. Un
37	49-80	521659.159	1621890.49	194626859	19462685.9	16218904.9	3819145.79	260829579	494957174.8	49495717
38										

§ A2.8 | Ditch: Volume

DITCH

Volumes

Zone	Zone Length	Ditch Width	Ditch Depth	Ditch Basewidth	Vol	
						Ditch BW assumed
Newcastle to Benwell	3560	9.14	4.57	0.3	76790.624	
Benwell to Rudchester	10730	8.23	2.08	0.3	95187.976	
East of Heddon on the Wall	14190	10.36	2.74	0.3	207233.598	
Stanley (mc23)	6410	7.92	3.35	0.3	88256.085	
Halton Chesters East Gate	2190	8.99	2.44	0.3	24821.022	
Chesters	9590	8.23	2.74	0.3	112069.699	
Cockmount Hill	2030	10.21	2.895	0.3	30882.8468	Avrg of nearby areas for dim
Carvoran to Thirlwall	1050	12.19	3.05	0.3	19999.6125	
Carvoran to Birdoswald	4290	10.06	3.66	2.74	100488.96	
Birdoswald	6980	8.23	2.74	0.3	81568.978	
Average Used	23490	9.26111111	3.04111111	0.3	341502.333	
Total					1178801.73	

§ A2.9 | Ditch: Labour

Workrate	Earth Excav.	Mid point of Primitive tools rate (3.00cuft/0.91cum hour) and modern tools rate	
	8	(3.58cuft/1.09cum hour) = 3.29cuft/1cum hour = 26.32cuft/8cum per day.	
	Source: Jewell, P.A. (ed.), *The Experimental Earthwork on Overton Down*, London, 1963. Chp. 5.		

Zone	Vol	Digging	Total Person Days
Newcastle to Benwell	76790.624	9598.828	9598.828
Benwell to Rudchester	95187.976	11898.497	11898.497
East of Heddon on the Wall	207233.598	25904.1998	25904.1998
Stanley (mc23)	88256.085	11032.0106	11032.0106
Halton Chesters East Gate	24821.022	3102.62775	3102.62775
Chesters	112069.699	14008.7124	14008.7124
Cockmount Hill	30882.8468	3860.35584	3860.35584
Carvoran to Thirlwall	19999.6125	2499.95156	2499.95156
Carvoran to Birdoswald	100488.96	12561.12	12561.12
Birdoswald	81568.978	10196.1223	10196.1223
Average Used	341502.333	42687.7916	42687.7916
Total	1178801.73	147350.217	147350.217
Build Team	6000	Comp Time	24.5583695

§ A2.10 | Ditch: Quantitative Survey

Quantitative Survey

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Zone	Turf Vol	Prob Total	Labour	Supervision	Turf	Total Cost	Con. Units	Cost W/out Turf
Newcastle to Benwell	76790.624	9598.828	1151859.36	115185.936	3071624.96	4338670.26	433867.0256	1267045.3
Benwell to Rudchester	95187.976	11898.497	1427819.64	142781.964	3807519.04	5378120.64	537812.0644	1570601.6
East of Heddon on the Wall	207233.598	25904.1998	3108503.97	310850.397	8289343.92	11708698.3	1170869.829	3419354.37
Stanley (mc23)	88256.085	11032.0106	1323841.28	132384.1275	3530243.4	4986468.8	498646.8803	1456225.4
Halton Chesters East Gate	24821.022	3102.62775	372315.33	37231.533	992840.88	1402387.74	140238.7743	409546.863
Chesters	112069.699	14008.7124	1681045.49	168104.5485	4482787.96	6331937.99	633193.7994	1849150.03
Cockmount Hill	30882.8468	3860.35584	463242.701	46324.27013	1235313.87	1744880.84	174488.0841	509566.971
Carvoran to Thirlwall	19999.6125	2499.95156	299994.188	29999.41875	799984.5	1129978.11	112997.8106	329993.606
Carvoran to Birdoswald	100488.96	12561.12	1507334.4	150733.44	4019558.4	5677626.24	567762.624	1658067.84
Birdoswald	81568.978	10196.1223	1223534.67	122353.467	3262759.12	4608647.26	460864.7257	1345888.14
Average Used	341502.333	42687.7916	5122534.99	512253.4988	13660093.3	19294881.8	1929488.179	5634788.49
Total	1178801.73	147350.217	17682026	1768202.601	47152069.4	66602298	6660229.796	19450228.6

§ A2.11 | Vallum: Ditch Volume

VALLUM

Volumes of Vallum Ditch

Zone	Length (M)	Top Width (M)	Base Width (M)	Depth (M)	Volume	Notes
Newcastle - Benwell	3333	5.18	2.67	2.74	35844.7485	Newc assumed as Benwell
Benwell - Rudchester	11110	7.32	2.36	2.31	124214.244	
Rudchester - Halton Chesters	11680	7.47	2.36	2.22	127443.984	TW+D avrg of adjacent used
Halton Chesters - Chesters	8570	7.62	2.57	2.13	93004.6395	
Chesters - Carrawburgh	4950	6.6925	2.57	2.283928571	52358.3488	
Carrawburgh - Housesteads	7300	6.1	1.37	3.05	83159.775	TW + BW as H'steads, scaled
Housesteads - Great Chesters	9079	3.81	3.2	1.98	63007.3521	Cut through limestone
Great Chesters - Carvoran	3968	10.36	1.22	3.2	73519.104	
Carvoran - Birdoswald	4031	5.79	1.52	1.52	22394.6236	
Birdoswald	888	5	3.05	3.15	11258.73	
Birdoswald - Castlesteads	10285	4.72	1.37	1.83	57311.6198	
Castlesteads	539	6.1	3.05	1.68	4142.754	
Castlesteads - Stanwix	11873	9.14	6.1	2.13	192705.914	
Stanwix	634	8.075	2.57	2.055	6934.52558	TW+D are average of adj'
Drumburgh - Bowness	11619	7.01	2.57	1.98	110196.92	
Average		6.6925	2.57	2.283928571	70499.8188	
Total					1057497.28	

§ A2.12 | Vallum: Mound Volume

7	Vallum Mounds		Height	Pi	Earth Excav		
8			1.22	3.14	8		
9							
0							
1	Zone	Zone Length (m)	S. Mound Width (M)	N. Mound Width (M)	S. Mound Volume	N. Mound Volume	Notes
2	Benwell - Rudchester	11110	5.49	5.79	58413.85803	61605.8721	S. turf revetted; N. stone kerbed.
3	Housesteads - Great Chesters	9079	2.44	2.44	21215.69825	21215.6983	Cut through limestone
4	Birdoswald - Castlesteads	10285	5.79	4.27	57031.17866	42059.263	Turf kerbed
5	Where Average Used	69385	5.64	5.03	374778.0818	334243.573	
6	Average (w/out limestone):		5.64	5.03	45553.57831	41626.9445	
7	Total:				511438.8167	459124.406	
8	Overall Total:						970563.223

§ A2.13 | Vallum: Ditch Labour

Ditch

Zone	Vol	Digging
Newcastle - Benwell	35844.7485	4480.59356
Benwell - Rudchester	124214.244	15526.7805
Rudchester - Halton Chesters	127443.984	15930.498
Halton Chesters - Chesters	93004.6395	11625.5799
Chesters - Carrawburgh	52358.3488	6544.7936
Carrawburgh - Housesteads	83159.775	10394.9719
Housesteads - Great Chesters	63007.3521	7875.91901
Great Chesters - Carvoran	73519.104	9189.888
Carvoran - Birdoswald	22394.6236	2799.32795
Birdoswald	11258.73	1407.34125
Birdoswald - Castlesteads	57311.6198	7163.95247
Castlesteads	4142.754	517.84425
Castlesteads - Stanwix	192705.914	24088.2392
Stanwix	6934.52558	866.815697
Drumburgh - Bowness	110196.92	13774.615
Avrg:	70499.8188	8812.47735
Total Pers. Days		132187.16
Build Team/Total	6000	22.0311934

§ A2.14 | Vallum: Mound Labour

				Core Ratio:	Turf Vol	Turf Cut/Lay	Turf/Core Haul
Mounds				3	0.02	44	216.36
Zone	S. Mound Vol	N. Mound Vol	S. Core	N. Core	Turf Num	Turf Cutting+	Turf Haulage
Benwell - Rudchester	58413.858	61605.8721	19471.286	20535.29071	4000657.67	90924.038	18490.74539
Housesteads - Great Chesters	21215.6983	21215.6983	7071.89942	7071.899417	1414379.88	32144.9974	6537.15975
Birdoswald - Castlesteads	57031.1787	42059.263	30042.3307	14971.91564	2703809.77	61450.2219	12496.80979
Where Average Used	374778.082	334243.573	124926.027	111414.5243	23634055.2	537137.617	109234.8639
Average (w/out av. areas)			18861.8387	14193.03526	2706282.44	61506.4191	12508.23831
Total			181511.543	153993.6301	31752902.5	721656.874	146759.5788
Build Team:	6000	Completion Time:					
Zone	Core Haul.	Pers. Days					
Benwell - Rudchester	9245.37269	118660.156					
Housesteads - Great Chesters	3268.57987	41950.737		Total Ditch & Vallum Labour			
Birdoswald - Castlesteads	10402.6267	84349.6584		1078137.625			
Where Average Used	54617.432	700989.913					
Average (w/out av.	7638.85976	81653.5172					
Total	77534.0113	945950.465					
Build Team:		157.658411					

§ A2.15 | Vallum: Quantitative Survey

Quantitative Survey

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Vallum Ditch Zone	Turf Vol	Prob Total	Labour	Supervision	Equipment	Turf	Total
Newcastle - Benwell	35844.7485	4480.59356	537671.228	53767.12275	44805.9356	1433789.94	2070034.226
Benwell - Rudchester	124214.244	15526.7805	1863213.66	186321.366	155267.805	4968569.76	7173372.591
Rudchester - Halton Chesters	127443.984	15930.498	1911659.76	191165.976	159304.98	5097759.36	7359890.076
Halton Chesters - Chesters	93004.6395	11625.5799	1395069.59	139506.9593	116255.799	3720185.58	5371017.931
Chesters - Carrawburgh	52358.3488	6544.7936	785375.232	78537.52316	65447.936	2094333.95	3023694.642
Carrawburgh - Housesteads	83159.775	10394.9719	1247396.63	124739.6625	103949.719	3326391	4802477.006
Housesteads - Great Chesters	63007.3521	7875.91901	945110.282	94511.02815	78759.1901	2520294.08	3638674.584
Great Chesters - Carvoran	73519.104	9189.888	1102786.56	110278.656	91898.88	2940764.16	4245728.256
Carvoran - Birdoswald	22394.6236	2799.32795	335919.354	33591.9354	27993.2795	895784.944	1293289.513
Birdoswald	11258.73	1407.34125	168880.95	16888.095	14073.4125	450349.2	650191.6575
Birdoswald - Castlesteads	57311.6198	7163.95247	859674.296	85967.42963	71639.5247	2292464.79	3309746.041
Castlesteads	4142.754	517.84425	62141.31	6214.131	5178.4425	165710.16	239244.0435
Castlesteads - Stanwix	192705.914	24088.2392	2890588.71	289058.8707	240882.392	7708236.55	11128766.52
Stanwix	6934.52558	866.815697	104017.884	10401.78836	8668.15697	277381.023	400468.852
Drumburgh - Bowness	110196.92	13774.615	1652953.8	165295.3797	137746.15	4407876.79	6363872.118
Vallum Mound Zon	Prob. Total	Labour	Supervision	Equipment			Total
Benwell - Rudchester	118660.156	14239218.7	1423921.87	1186601.561			16849742.16
Housesteads - Great Chesters	41950.737	5034088.44	503408.844	419507.3698			5957004.651
Birdoswald - Castlesteads	84349.6584	10121959	1012195.9	843496.5845			11977651.5
Where Average Used	700989.913	84118789.6	8411878.96	7009899.131			99540567.66
	Turf Vol	Prob Total	Labour	Supervision	Equipment	Turf	Total
Overall Total	1057497.28	1078137.62	129376515	12937651.5	10781376.2	42299891.3	195395434
Build Team/Comp	6000	179.689604					

§ A2.16 | Stone Wall Turrets: Dimensions

Name	Wall	Length	Width	Portal	Notes
7b	North	4.27	1.22		
	South	4.27	0.81	1.12	
	East	5.99	0.81		
	West	5.99	0.81		
10a	North	4.2	1.3		
	South	4.2	0.92	1.07	
	East	6.32	0.92		
	West	6.32	0.92		
12a	North	3.96	1.98		
	South	3.96	1.22	1.07	
	East	6.4	1.22		
	West	6.4	1.22		
12b	North	3.96	1.98		
	South	3.96	1.22	1.07	
	East	6.4	1.22		
	West	6.4	1.22		
13a	North	3.96	1.98		
	South	3.96	1.22	1.07	
	East	6.4	1.22		
	West	6.4	1.22		
17a	North	4.27	1.52		
	South	4.27	0.86	1.01	
	East	6.04	0.86		
	West	6.04	0.86		

17b	North	3.96	1.52		
	South	3.96	1.07	1.07	
	East	6.86	1.07		
	West	6.86	1.07		
18a	North	4.27	1.37		
	South	4.27	0.91	1.01	
	East	5.79	0.91		
	West	5.79	0.91		
18b	North	4.62	1.52		
	South	4.62	0.94	0.86	
	East	3.81	0.94		
	West	3.81	1.01		
19a	North	3.86	1.52		
	South	3.86	1.31	1.07	
	East	6.19	1.31		
	West	6.19	1.31		
19b	North	3.35	1.52		
	South	3.35	1.22	0.91	
	East	6.1	1.22		
	West	6.1	1.22		
25b	North	4.14	1.6		
	South	4.14	0.91	0.91	
	East	5.97	0.91		
	West	5.97	0.91		
26a	North	3.66	1.6		
	South	3.66	1.16	1.07	
	East	6.58	1.16		
	West	6.58	1.16		
26b	North	4.11	0.84		
	South	4.01	0.84	1.02	Avrg Door
	East	5.49	0.84		
	West	5.57	0.84		

29a	North	3.53	1.6		
	South	3.43	1.09	0.91	
	East	6.25	1.09		
	West	6.13	1.09		
29b	North	3.91	1.4		
	South	3.91	0.86	0.91	
	East	5.92	0.86		
	West	5.92	0.86		
33b	North	4.18	1.12		
	South	4.18	0.88	1.1	
	East	5.96	0.92		
	West	5.96	0.88		
34a	North	3.89	1.22		
	South	3.89	0.91	0.91	
	East	5.79	0.91		
	West	5.79	0.91		
35a	North	3.81	1.98		
	South	3.81	0.91	0.86	
	East	5.85	0.91		
	West	5.85	0.91		
39a	North	4.16	0.84		
	South	4.16	0.84	1.04	
	East	5.64	0.84		
	West	5.67	0.84		
39b	North	3.53	1.27		
	South	3.52	0.91	1.02	Avrg Door
	East	5.08	0.91		
	West	5.08	0.91		
41a	North	2.97	1.45		
	South	2.97	1.19	1.01	
	East	5.87	1.19		
	West	5.87	1.19		

44b	North	3.12	1.83		
	South	3.05	0.99	0.86	
	East	5.89	1.83		
	West	5.97	0.99		
45a	North	5.84	0.84		
	South	5.67	0.86	1.07	
	East	5.49	0.84		
	West	5.56	0.86		
45b	North	3.86	1.4		
	South	3.86	0.86	1.01	
	East	5.99	0.86		
	West	5.99	0.86		
48a	North	4.04	0.96		
	South	4.37	0.89	1.07	
	East	5.72	0.89		
	West	5.97	0.89		
48b	North	4.2	0.84		
	South	4.2	0.79	1.02	Avrg Door
	East	5.52	0.79		
	West	5.52	0.79		

§ A2.17 | Stone Wall Turrets: Volume

Volume

Name	Type 1 Tap	Type 2 Tap	Type 3 Tap	Type 1 NT	Type 2 NT	Type 3 NT
7b	132.787816	146.638816	160.489816	185.787636	213.345486	240.903336
10a	145.364332	159.566332	173.768332	211.976172	243.405372	274.834572
12a	176.235842	190.221842	204.207842	286.82424	329.25624	371.68824
12b	176.235842	190.221842	204.207842	286.227042	328.659042	371.091042
13a	176.235842	190.221842	204.207842	286.227042	328.659042	371.091042
17a	142.706938	156.625438	170.543938	208.086858	238.913958	269.741058
17b	164.175847	178.782847	193.389847	252.328887	289.734087	327.139287
18a	140.089353	153.670353	167.251353	205.161873	235.571973	265.982073
18b	125.270412	136.650912	148.031412	190.275072	218.467122	246.659172
19a	169.403031	182.970531	196.538031	274.363311	315.075711	355.788111
19b	153.241146	165.998646	178.756146	243.477546	279.572046	315.666546
25b	144.838383	158.486883	172.135383	215.353623	247.238823	279.124023
26a	162.871556	176.695556	190.519556	256.548516	294.599316	332.650116
26b	119.432544	132.379044	145.325544	162.817704	186.984504	211.151304
29a	149.397697	162.452197	175.506697	231.629517	265.950867	300.272217
29b	133.610998	146.881498	160.151998	192.608598	221.137098	249.665598
33b	135.20464	148.89364	162.58264	192.98424	221.61624	250.24824
34a	131.887263	144.955263	158.023263	190.533963	218.769213	247.004463
35a	144.334758	157.375758	170.416758	219.525378	252.012228	284.499078
39a	122.240508	135.490758	148.741008	166.643568	191.377368	216.111168
39b	117.775546	129.392296	141.009046	171.062466	196.460316	221.858166
41a	139.987597	151.921597	163.855597	220.348917	253.066017	285.783117
44b	157.390962	169.561212	181.731462	257.757642	295.884792	334.011942
45a	141.622846	169.298412	181.414662	257.757642	295.884792	334.011942
45b	133.595738	146.893238	160.190738	192.531858	221.071458	249.611058
48a	130.731349	144.298849	157.866349	183.666789	210.924489	238.182189
48b	117.809574	130.931574	144.053574	157.363254	180.714654	204.066054
Avrg:	143.869569	157.68434	170.92284	218.51368	250.901935	283.290191

§ A2.18 | Stone Wall Turrets: Labour

Workrate

Type I

Turret Number	Type1 Tap. V	Haulage Low	High	Building Low	High	Mortar Low	High	Shaping	Scaffold
7b	132.787816	177.050421	53.1151264	11.7384429	23.4768859	296.382405	592.764811	92.6195017	39.489187
10a	145.364332	193.819109	58.1457328	12.8502069	25.7004139	324.453189	648.906378	101.391622	43.229262
12a	176.235842	234.981123	70.4943368	15.5792484	31.1584969	393.358399	786.716799	122.9245	52.410005
12b	176.235842	234.981123	70.4943368	15.5792484	31.1584969	393.358399	786.716799	122.9245	52.410005
13a	176.235842	234.981123	70.4943368	15.5792484	31.1584969	393.358399	786.716799	122.9245	52.410005
17a	142.706938	190.275917	57.0827752	12.6152933	25.2305866	318.521886	637.043771	99.5380893	42.438991
17b	164.175847	218.901129	65.6703388	14.5131449	29.0262897	366.440491	732.880981	114.512653	48.823536
18a	140.089353	186.785804	56.0357412	12.3838988	24.7677976	312.679436	625.358872	97.7123237	41.660559
18b	125.270412	167.027216	50.1081648	11.0739044	22.1478088	279.60356	559.207119	87.3761124	37.253619
19a	169.403031	225.870708	67.7612124	14.9752279	29.9504559	378.107565	756.21513	118.158614	50.378026
19b	153.241146	204.321528	61.2964584	13.5465173	27.0930346	342.034238	684.068476	106.885699	45.571713
25b	144.838383	193.117844	57.9353532	12.8037131	25.6074261	323.279271	646.558542	101.024772	43.072852
26a	162.871556	217.162075	65.1486224	14.3978456	28.7956911	363.529313	727.058626	113.60291	48.435659
26b	119.432544	159.243392	47.7730176	10.5578369	21.1156738	266.573438	533.146876	83.3041994	35.517521
29a	149.397697	199.196929	59.7590788	13.2067564	26.4135128	333.45566	666.911319	104.204894	44.428727
29b	133.610998	178.147997	53.4443992	11.8112122	23.6224244	298.219748	596.439495	93.1936711	39.73399
33b	135.20464	180.272853	54.081856	11.9520902	23.9041804	301.776756	603.553513	94.3052364	40.207916
34a	131.887263	175.849684	52.7549052	11.658834	23.3176681	294.372371	588.744742	91.9913659	39.221376
35a	144.334758	192.446344	57.7339032	12.7591926	25.5183852	322.15518	644.31036	100.673494	42.923082
39a	122.240508	162.987344	48.8962032	10.8060609	21.6121218	272.840814	545.681628	85.2627543	36.352569
39b	117.775546	157.034061	47.1102184	10.4113583	20.8227165	262.875019	525.750037	82.1484433	35.024754
41a	139.987597	186.650129	55.9950388	12.3749036	24.7498071	312.452317	624.904633	97.6413489	41.630298
44b	157.390962	209.854616	62.9563848	13.913361	27.8267221	351.296627	702.593254	109.780196	46.805809
45a	141.622846	188.830461	56.6491384	12.5194596	25.0389192	316.102192	632.204385	98.7819351	42.116598
45b	133.595738	178.127651	53.4382952	11.8098632	23.6197265	298.185687	596.371374	93.1830273	39.729451
48a	130.731349	174.308465	52.2925396	11.5566513	23.1133025	291.792371	583.584742	91.1851159	38.877623
48b	117.809574	157.079432	47.1238296	10.4143663	20.8287327	262.950969	525.901938	82.1721779	35.034873
Avrg:	143.869569	191.826092	57.5478276	12.7180699	25.4361398	321.116878	642.233756	100.349024	42.784741

Building Times

Turret	Prob. Total	Build Team	Est Comp. Time
7b	493.344663	8	61.6680829
10a	540.070012	8	67.5087516
12a	654.76649	8	81.8458112
12b	654.76649	8	81.8458112
13a	654.76649	8	81.8458112
17a	530.197035	8	66.2746293
17b	609.960164	8	76.2450205
18a	520.471959	8	65.0589949
18b	465.41536	8	58.1769201
19a	629.380645	8	78.6725807
19b	569.334626	8	71.1668283
25b	538.115962	8	67.2644952
26a	605.11435	8	75.6392938
26b	443.726013	8	55.4657517
29a	555.055115	8	69.3818894
29b	496.40302	8	62.0503775
33b	502.323855	8	62.7904819
34a	489.998852	8	61.2498565
35a	536.244851	8	67.0306064
39a	454.158402	8	56.7698002
39b	437.569793	8	54.6962241
41a	520.093906	8	65.0117383
44b	584.752378	8	73.0940472
45a	526.169323	8	65.7711654
45b	496.346324	8	62.0432906
48a	485.704301	8	60.7130376
48b	437.696216	8	54.712027
Avrg:	534.516541		66.8145676

§ A2.19 | Stone Wall Turrets: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Type I

Turret	Stone Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Cost in £'s	Con. Units
7b	132.787816	493.344663	59201.3596	5920.13596	4933.44663	1481.91203	66393.908	137930.762	13793.076
10a	145.364332	540.070012	64808.4015	6480.84015	5400.70012	1622.26595	72682.166	150994.374	15099.437
12a	176.235842	654.76649	78571.9788	7857.19788	6547.6649	1966.792	88117.921	183061.555	18306.155
12b	176.235842	654.76649	78571.9788	7857.19788	6547.6649	1966.792	88117.921	183061.555	18306.155
13a	176.235842	654.76649	78571.9788	7857.19788	6547.6649	1966.792	88117.921	183061.555	18306.155
17a	142.706938	530.197035	63623.6442	6362.36442	5301.97035	1592.60943	71353.469	148234.057	14823.406
17b	164.175847	609.960164	73195.2196	7319.52196	6099.60164	1832.20245	82087.9235	170534.469	17053.447
18a	140.089353	520.471959	62456.6351	6245.66351	5204.71959	1563.39718	70044.6765	145515.092	14551.509
18b	125.270412	465.41536	55849.8433	5584.98433	4654.1536	1398.0178	62635.206	130122.205	13012.22
19a	169.403031	629.380645	75525.6774	7552.56774	6293.80645	1890.53783	84701.5155	175964.105	17596.41
19b	153.241146	569.334626	68320.1552	6832.01552	5693.34626	1710.17119	76620.573	159176.261	15917.626
25b	144.838383	538.115962	64573.9154	6457.39154	5381.15962	1616.39635	72419.1915	150448.054	15044.805
26a	162.871556	605.11435	72613.722	7261.3722	6051.1435	1817.64656	81435.778	169179.662	16917.966
26b	119.432544	443.726013	53247.1216	5324.71216	4437.26013	1332.86719	59716.272	124058.233	12405.823
29a	149.397697	555.055115	66606.6139	6660.66139	5550.55115	1667.2783	74698.8485	155183.953	15518.395
29b	133.610998	496.40302	59568.3624	5956.83624	4964.0302	1491.09874	66805.499	138785.827	13878.583
33b	135.20464	502.323855	60278.8626	6027.88626	5023.23855	1508.88378	67602.32	140441.191	14044.119
34a	131.887263	489.998852	58799.8622	5879.98622	4899.98852	1471.86186	65943.6315	136995.33	13699.533
35a	144.334758	536.244851	64349.3821	6434.93821	5362.44851	1610.7759	72167.379	149924.924	14992.492
39a	122.240508	454.158402	54499.0082	5449.90082	4541.58402	1364.20407	61120.254	126974.951	12697.495
39b	117.775546	437.569793	52508.3751	5250.83751	4375.69793	1314.37509	58887.773	122337.059	12233.706
41a	139.987597	520.093906	62411.2687	6241.12687	5200.93906	1562.26158	69993.7985	145409.395	14540.939
44b	157.390962	584.752378	70170.2854	7017.02854	5847.52378	1756.48314	78695.481	163486.802	16348.68
45a	141.622846	526.169323	63140.3188	6314.03188	5261.69323	1580.51096	70811.423	147107.978	14710.798
45b	133.595738	496.346324	59561.5589	5956.15589	4963.46324	1490.92844	66797.869	138769.976	13876.998
48a	130.731349	485.704301	58284.5161	5828.45161	4857.04301	1458.96185	65365.6745	135794.647	13579.465
48b	117.809574	437.696216	52523.546	5252.3546	4376.96216	1314.75485	58904.787	122372.405	12237.24
Avrg:	143.869569	534.516541	64141.9849	6414.19849	5345.16541	1605.58439	71934.7844	149441.718	14944.172
Total:	3884.47836	14431.9466	1731833.59	173183.359	144319.466	43350.7785	1942239.18	4034926.38	403492.64

§ A2.20 | Turf Wall Turrets: Dimensions

Dimensions

Name	Wall	Length	Width	Portal	Notes
50a	North	3.96	1.22		Avrg Door size used
	South	3.96	0.99	1.03	Scaled from diagram
	East	6.1	0.76		
	West	6.1	0.76		
50b	North	4.04	0.99		Scaled from diagram
	South	4.04	0.99	1.03	
	East	6.1	0.99		
	Wall	6.1	0.91		
51a	North	4.3	0.95		
	South	4.3	0.95	0.91	
	East	6	0.75		
	West	6	0.75		
52a	North	4.42	0.76		Scaled from diagram
	South	4.42	0.76	0.91	
	East	5.94	0.69		
	West	5.94	0.69		
53a	North	4.5	0.84		Door scaled from diagram
	South	4.5	0.84	0.91	
	East	6.02	0.76		
	West	6.02	0.76		
54a(i)	North	4.27	1.52		Scaled from diagram
	South	4.27	1.52	1.22	
	East	6.25	1.37		
	West	6.25	1.37		
54a(ii)	North	4.11	1.2		Scaled from diagram
	South	4.11	1.2	1.22	
	East	6.1	1.22		
	West	6.1	1.22		
72b	North	3.96	1.22		Avrg Door size used
	South	3.96	1.22	1.03	Scaled from diagram
	East	5.94	0.91		
	West	5.94	0.91		
79b	North	4.18	1.11		Avrg Door size used
	South	4.18	1.11	1.03	20Rft. Assumed for length
	East	6.1	0.96		
	West	6.1	0.96		

§ A2.21 | Turf Wall Turrets: Volumes

Volume

Name	Type 1 Tap	Type 2 Tap	Type 3 Tap	Type 1 NT	Type 2 NT	Type 3 NT
50a	130.012171	143.593171	157.174171	182.035851	209.071251	236.106651
50b	137.318411	151.007411	164.696411	198.004971	227.388771	256.772571
51a	127.783835	141.688835	155.593835	173.603835	199.358835	225.113835
52a	118.483708	132.469708	146.455708	150.914988	173.288388	195.661788
53a	127.087172	141.289172	155.491172	169.093092	194.158692	219.224292
54a(i)	184.097632	198.299632	212.501632	303.796872	348.955572	394.114272
54a(ii)	159.59612	173.37962	187.16312	249.83832	286.96032	324.08232
72b	139.535898	152.900898	166.265898	206.602458	237.312258	268.022058
79b	144.000999	157.878999	171.756999	212.090679	243.578079	275.065479
Avrg:	140.87955	154.72305	168.56655	205.109007	235.563574	266.018141

§ A2.22 | Turf Wall Turrets: Labour

Workrate

Type I

Turret		Haulage		Building		Mortar			
Number	Type1 Tap. V	Low	High	Low	High	Low	High	Shaping	Scaffold
50a	130.012171	173.349561	52.0048684	11.4930759	22.9861518	290.187166	580.374331	90.6834893	38.6638
50b	137.318411	183.091215	54.9273644	12.1389475	24.2778951	306.494693	612.989387	95.7795917	40.8365
51a	127.783835	170.378447	51.113534	11.296091	22.592182	285.21352	570.427039	89.1292249	38.0011
52a	118.483708	157.978277	47.3934832	10.4739598	20.9479196	264.455636	528.911273	82.6423863	35.2354
53a	127.087172	169.449563	50.8348688	11.234506	22.469012	283.658568	567.317136	88.6433025	37.7939
54a(i)	184.097632	245.463509	73.6390528	16.2742307	32.5484613	410.905915	821.811829	128.408098	54.748
54a(ii)	159.59612	212.794827	63.838448	14.108297	28.216594	356.21854	712.43708	111.318294	47.4616
72b	139.535898	186.047864	55.8143592	12.3349734	24.6699468	311.444124	622.888249	97.3262889	41.496
79b	144.000999	192.001332	57.6003996	12.7296883	25.4593766	321.41023	642.82046	100.440697	42.8238
Avrg		187.839399	56.3518198	12.4537522	24.9075044	314.443155	628.886309	98.2634858	41.8956

Building Times

Turret	Prob. Total	Build Team	Est Comp. Time
50a	483.032349	8	60.3790437
50b	510.177118	8	63.7721397
51a	474.753445	8	59.3441806
52a	440.200817	8	55.0251021
53a	472.165143	8	59.0206428
54a(i)	683.975285	8	85.4969106
54a(ii)	592.94517	8	74.1181462
72b	518.415715	8	64.8019644
79b	535.004841	8	66.8756051
Avrg:	523.407765		65.4259706

§ A2.23 | Turf Wall Turrets: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Turret	Stone Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Cost in £'s	Construc.
50a	130.012171	483.032349	57963.8819	5796.38819	4830.32349	1450.93583	65006.0855	135047.615	13504.8
50b	137.318411	510.177118	61221.2541	6122.12541	5101.77118	1532.47347	68659.2055	142636.83	14263.7
51a	127.783835	474.753445	56970.4134	5697.04134	4747.53445	1426.0676	63891.9175	132732.974	13273.3
52a	118.483708	440.200817	52824.098	5282.4098	4402.00817	1322.27818	59241.854	123072.648	12307.3
53a	127.087172	472.165143	56659.8171	5665.98171	4721.65143	1418.29284	63543.586	132009.329	13200.9
54a(i)	184.097632	683.975285	82077.0342	8207.70342	6839.75285	2054.52957	92048.816	191227.836	19122.8
54a(ii)	159.59612	592.94517	71153.4204	7115.34204	5929.4517	1781.0927	79798.06	165777.367	16577.7
72b	139.535898	518.415715	62209.8859	6220.98859	5184.15715	1557.22062	69767.949	144940.201	14494
79b	144.000999	535.004841	64200.5809	6420.05809	5350.04841	1607.05115	72000.4995	149578.238	14957.8
Avrg:	140.87955	523.407765	62808.9318	6280.89318	5234.07765	1572.21577	70439.7748	146335.893	14633.6
Total:	1267.91595	4710.66988	565280.386	56528.0386	47106.6988	14149.942	633957.973	1317023.04	131702

§ A2.24 | Stone Wall Milecastles: Dimensions and Wall Volumes

Name	Wall	Length	Width	Wall Vol	Portal Width	Portal Vol	Notes
9	North	14.88	2.92	141.7952	2.74	10.3835725	
	South	14.88	2.54	123.3424	2.74	8.5354425	
	East	18.29	2.74	200.4584	0	0	
	West	18.29	2.74	200.4584	0	0	
10	North	14.33	2.92	134.5536	2.81	10.6488463	Avrg Portal
	South	14.33	2.92	134.5536	2.81	10.6488463	Avrg Portal
	East	17.68	2.92	206.5024	0	0	
	West	17.68	2.92	206.5024	0	0	
13	North	18.21	2.92	180.6896	2.74	10.3835725	
	South	18.21	2.33	144.1804	2.74	7.5141075	
	East	15.24	2.33	142.0368	0	0	
	West	15.24	2.33	142.0368	0	0	
17	North	17.68	2.79	168.4044	2.59	9.21748625	
	South	17.68	2.41	145.4676	2.59	7.47053125	
	East	14.94	2.41	144.0216	0	0	
	West	14.94	2.41	144.0216	0	0	
18	North	16.36	2.82	153.6336	2.74	9.8972225	
	South	16.36	2.36	128.5728	2.74	7.6600125	
	East	18.14	2.36	171.2416	0	0	
	West	18.14	2.36	171.2416	0	0	
19	North	16.25	2.44	130.296	2.9	8.5191125	
	South	16.25	2.38	127.092	2.9	8.2102625	
	East	17.14	2.38	163.1728	0	0	
	West	17.14	2.38	163.1728	0	0	
20	North	16.56	2.92	161.4176	2.74	10.3835725	
	South	16.56	2.13	117.7464	2.74	6.5414075	
	East	17.98	2.13	153.1896	0	0	
	West	17.98	2.13	153.1896	0	0	
27	North	14.63	2.9	132.008	3.25	12.2009063	
	South	14.63	2.9	132.008	3.25	12.2009063	
	East	17.91	2.9	207.756	0	0	
	West	17.91	2.9	207.756	0	0	
29	North	16.46	2.92/2.31	142.779	2.81	9.1275825	Avrg Portal;
	South	16.46	2.13	116.298	2.81	6.70852375	Avrg Portal
	East	18.59	2.13	158.3868	0	0	
	West	18.59	2.13	158.3868	0	0	
30	North	16.46	2.92	159.432	2.81	10.6488463	Avrg Portal
	South	16.46	2.21	120.666	2.81	7.10754375	Avrg Portal
	East	17.37	2.21	153.5508	0	0	
	West	17.37	2.21	153.5508	0	0	

33	North	16.4	2.29	123.66	2.9	7.7469875	
	South	16.4	2.13	115.02	2.9	6.9233875	Portal w matches N.
	East	28.19	2.21	249.1996	0	0	
	West	28.19	2.11	237.9236	0	0	
37	North	17.53	2.29	132.6368	3.05	8.14769375	
	South	17.53	2.59	150.0128	3.05	9.77181875	
	East	15.12	2.59	156.6432	0	0	
	West	15.12	2.59	156.6432	0	0	
38	North	18.59	2.99	189.566	2.74	10.7240175	
	South	18.59	2.49	157.866	2.74	8.2922675	
	East	14.94	2.49	148.8024	0	0	
	West	14.94	2.49	148.8024	0	0	
39	North	15.04	2.31	115.038	2.59	7.01080625	
	South	15.04	2.13	106.074	2.59	6.18330125	
	East	18.82	2.13	160.3464	0	0	
	West	18.82	2.13	160.3464	0	0	
40	North	14.86	2.31	109.1244	3.05	8.25596875	
	South	14.86	2.06	101.9288	2.49	5.63518125	
	East	18.9	2.06	155.736	0	0	
	West	18.9	2.06	155.736	0	0	
42	North	17.83	2.79	168.4044	2.74	9.7513175	
	South	17.83	2.44	147.2784	2.74	8.0490925	
	East	14.78	2.44	144.2528	0	0	
	West	14.78	2.44	144.2528	0	0	
47	North	18.29	2.74	173.716	2.44	8.467105	
	South	18.29	2.74	173.716	2.44	8.467105	
	East	21.03	2.74	230.4888	0	0	
	West	21.03	2.74	230.4888	0	0	
48	North	18.52	2.74	171.1952	2.9	10.0633625	
	South	18.52	2.74	171.1952	2.9	10.0633625	
	East	21.34	2.74	233.8864	0	0	
	West	21.34	2.74	233.8864	0	0	
49	North	19.81	2.74	183.1416	3.1	10.7573875	
	South	19.81	2.31	154.4004	3.1	8.3913125	
	East	23.16	2.31	213.9984	0	0	
	West	23.16	2.31	213.9984	0	0	

§ A2.25 | Stone Wall Milecastles: Gateway Area Volumes

MC Pivot-floor joist

Name	Length	Width	Total Vol.
9 North	2.74	2.92	4.880488
9 South	2.74	2.54	4.245356
10 North	2.81	2.92	5.005172
10 South	2.81	2.92	5.005172
13 North	2.74	2.92	4.880488
13 South	2.74	2.33	3.894362
17 North	2.59	2.79	4.407921
17 South	2.59	2.41	3.807559
18 North	2.74	2.82	4.713348
18 South	2.74	2.36	3.944504
19 North	2.9	2.44	4.31636
19 South	2.9	2.38	4.21022
20 North	2.74	2.92	4.880488
20 South	2.74	2.13	3.560082
27 North	3.25	2.9	5.74925
27 South	3.25	2.9	5.74925
29 North	2.81	2.92/2.31	4.4823715
29 South	2.81	2.13	3.651033
30 North	2.81	2.92	5.005172
30 South	2.81	2.21	3.788161
33 North	2.9	2.29	4.05101
33 South	2.9	2.13	3.76797
37 North	3.05	2.29	4.260545
37 South	3.05	2.59	4.818695
38 North	2.74	2.99	4.997486
38 South	2.74	2.49	4.161786
39 North	2.59	2.31	3.649569
39 South	2.59	2.13	3.365187
40 North	3.05	2.31	4.297755
40 South	2.49	2.06	3.128934
42 North	2.74	2.79	4.663206
42 South	2.74	2.44	4.078216
47 North	2.44	2.74	4.078216
47 South	2.44	2.74	4.078216
48 North	2.9	2.74	4.84706
48 South	2.9	2.74	4.84706
49 North	3.1	2.74	5.18134
49 South	3.1	2.31	4.36821

§ A2.26 | Stone Wall Milecastles: Tower Dimensions

MC Towers

Name	Source	N. Width	N. Length	S. Width	S. Length	N. Area	S. Area	Notes
9	AA(4) 7, 152	0	0	5.03	2.59	0	13.0277	
13		5.64	3.35	0	0	18.894	0	
17		5.33	3.15	0	0	16.7895	0	
18		6.2	3.33	0	0	20.646	0	
19		0	0	5.79	3.45	0	19.9755	
20		5.33	3.51	0	0	18.7083	0	
27		0	0	3.55	2.84	0	10.082	No jams, area is just what is above passage
33		6.1	2.74	0	0	16.714	0	
37		6.3	3.1	6.3	3.1	19.53	19.53	
38		0	0	5.79	3.05	0	17.6595	
39		5.33	3.05	5.79	2.74	16.2565	15.8646	
40		0	0	5	3	0	15	
42		5.79	2.9	5.79	3.05	16.791	17.6595	
47		6.4	4.27	6.4	4.27	27.328	27.328	
48		5.26	3.96	0	0	20.8296	0	
					AVRG:	21.3874333	17.3474222	19.3674278

§ A2.27 | Stone Wall Milecastles: Tower Volumes

Towers

Name	Tower	Type 1 Tap	Type 2 Tap	Type 3 Tap
9	South	42.83361	54.33561	65.83761
13	North	49.98501	63.33651	76.68801
17	North	47.32281	59.98581	72.64881
18	North	52.80381	66.88431	80.96481
19	South	51.29001	64.97901	78.66801
20	North	49.20201	62.35101	75.50001
27	South	36.41301	46.25451	56.09601
33	North	49.20201	62.35101	75.50001
37	North	52.12521	66.03021	79.93521
	South	52.12521	66.03021	79.93521
38	South	49.20201	62.35101	75.50001
39	North	46.80081	59.32881	71.85681
	South	47.58381	60.31431	73.04481
40	South	44.81721	56.83221	68.84721
42	North	48.41901	61.36551	74.31201
	South	49.20201	62.35101	75.50001
47	North	58.75461	74.37411	89.99361
	South	58.75461	74.37411	89.99361
48	North	51.18561	64.84761	78.50961
	Avrg:	49.3695995	62.5619416	75.7542837

§ A2.28 | Stone Wall Milecastles: Total Volumes

Volumes

Number	Reference	Basic Vol	Tower Vol	Gateway Vol.	Brrk S Vol	Brrk T Vol	Total Vol	Notes
9		666.0544	92.2032095	28.044859	312.604227	72.266	1098.9067	Avrg on S. tower
10		682.112	98.7391989	31.3080365	312.604227	72.266	1124.76346	Avrg on both towers
13		608.9436	99.3546095	26.67253	312.604227	72.266	1047.57497	Avrg on S. tower
17		601.9152	96.6924095	24.9034975	312.604227	72.266	1036.11533	Avrg on S. tower
18		624.6896	102.173409	26.215087	312.604227	72.266	1065.68232	Avrg on S. tower
19		583.7336	100.659609	25.255955	312.604227	72.266	1022.25339	Avrg on N. tower
20		585.5432	98.5716095	25.36555	312.604227	72.266	1022.08459	Avrg on S. tower
27		679.528	85.7826095	35.9003125	312.604227	72.266	1113.81515	Avrg on N. tower
29		575.8506	98.7391989	23.9695108	312.604227	72.266	1011.16354	Avrg on both towers
30		587.1996	98.7391989	26.549723	312.604227	72.266	1025.09275	Avrg on both towers
33		725.8032	98.5716095	22.489355	312.604227	72.266	1159.46839	Avrg on S. tower
37		595.936	104.25042	26.9987525	312.604227	72.266	1039.7894	
38		645.0368	98.5716095	28.175557	312.604227	72.266	1084.38819	Avrg on N. tower
39		541.8048	94.38462	20.2088635	312.604227	72.266	969.002511	
40		522.5252	94.1868095	21.317839	312.604227	72.266	950.634076	Avrg on N. tower
42		604.1884	97.62102	26.541832	312.604227	72.266	1040.95548	
47		808.4096	117.50922	25.090642	625.208454	144.532	1576.21792	Two barrack blocks presumed
48		810.1632	100.555209	29.820845	625.208454	144.532	1565.74771	Avrg on S. tower; Two barrack blocks presumed
49		765.5388	98.7391989	28.69825	312.604227	72.266	1205.58048	Avrg on both towers
						Avrg:	1113.64402	

§ A2.29 | Stone Wall Milecastles: Labour

Stone MC		Haulage		Building		Mortar				
Number	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold	Barrack Block
9	1098.9067	1465.20893	439.562678	81.3190955	162.638191	2769.24487	5538.48975	865.389023	127.1966	1623.59531
10	1124.76346	1499.68462	449.905385	83.2324962	166.464992	2834.40393	5668.80785	885.751227	132.31007	1623.59531
13	1047.57497	1396.76662	419.029987	77.5205475	155.041095	2639.88892	5279.77783	824.965286	126.81981	1623.59531
17	1036.11533	1381.48711	414.446134	76.6725347	153.345069	2611.01064	5222.02128	815.940826	124.66744	1623.59531
18	1065.68232	1420.90976	426.272929	78.860492	157.720984	2685.51946	5371.03891	839.22483	129.54681	1623.59531
19	1022.25339	1363.00452	408.901357	75.646751	151.293502	2576.07855	5152.15709	805.024546	125.55447	1623.59531
20	1022.08459	1362.77945	408.833835	75.6342594	151.268519	2575.65316	5151.30632	804.891612	124.52777	1623.59531
27	1113.81515	1485.08687	445.52606	82.422321	164.844642	2806.81418	5613.62835	877.12943	125.19656	1623.59531
29	1011.16354	1348.21805	404.465415	74.8261017	149.652203	2548.13211	5096.26423	796.291285	123.79008	1623.59531
30	1025.09275	1366.79033	410.0371	75.8568634	151.713727	2583.23373	5166.46746	807.26054	124.83477	1623.59531
33	1159.46839	1545.95786	463.787357	85.800661	171.601322	2921.86035	5843.72069	913.081358	134.83155	1623.59531
37	1039.7894	1386.38587	415.91576	76.9444156	153.888831	2620.26929	5240.53857	818.834152	128.61355	1623.59531
38	1084.38819	1445.85092	433.755277	80.2447263	160.489453	2732.65825	5465.3165	853.955703	129.20054	1623.59531
39	969.002511	1292.00335	387.601004	71.7061858	143.412372	2441.88633	4883.77265	763.089477	118.51319	1623.59531
40	950.634076	1267.5121	380.25363	70.3469216	140.693843	2395.59787	4791.19574	748.624335	117.03949	1623.59531
42	1040.95548	1387.94064	416.382192	77.0307055	154.061411	2623.20781	5246.41562	819.75244	125.48143	1623.59531
47	1576.21792	2101.62389	630.487167	116.640126	233.280252	3972.06915	7944.1383	1241.27161	175.28484	3247.19061
48	1565.74771	2087.66361	626.299084	115.86533	231.730661	3945.68423	7891.36845	1233.02632	166.26584	3247.19061
49	1205.58048	1607.44063	482.23219	89.2129552	178.42591	3038.0628	6076.1256	949.394625	138.37135	1623.59531
Avrg:	1113.64402	1484.85869	445.457607	82.4096574	164.819315	2806.38293	5612.76585	876.994664	131.47611	1794.50007

Number	Prob Total	Est.Build Tea	Comp. Time	Alt Team	Comp. Time
9	5906.30758	12	492.192298	16	369.144224
10	6009.19841	12	500.766534	16	375.574901
13	5711.81985	12	475.984988	16	356.988741
17	5666.33288	12	472.194406	16	354.145805
18	5783.01983	12	481.918319	16	361.438739
19	5614.80097	12	467.900081	16	350.925061
20	5613.13594	12	467.761328	16	350.820996
27	5960.68386	12	496.723655	16	372.542741
29	5571.1003	12	464.258358	16	348.193769
30	5624.8183	12	468.734859	16	351.551144
33	6142.95658	12	511.913048	16	383.934786
37	5684.17247	12	473.681039	16	355.260779
38	5853.4098	12	487.78415	16	365.838112
39	5406.39149	12	450.532624	16	337.899468
40	5335.45756	12	444.621463	16	333.466097
42	5685.44988	12	473.78749	16	355.340617
47	9382.9435	12	781.911958	32	293.216984
48	9334.33141	12	777.860951	32	291.697857
49	6320.86922	12	526.739102	16	395.054326
Avrg:	6137.22104		511.435087		352.791324

§ A2.30 | Stone Wall Milecastles: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Number	Stone Vol	Timber Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Timber Cos	Cost in £'s	Con. Units
9	1098.9067	72.266	5906.30758	708756.909	70875.6909	59063.0758	12263.7987	549453.348	10839.9	1411252.72	141125.272
10	1124.76346	72.266	6009.19841	721103.809	72110.3809	60091.9841	12552.3602	562381.731	10839.9	1439080.17	143908.017
13	1047.57497	72.266	5711.81985	685418.382	68541.8382	57118.1985	11690.9366	523787.483	10839.9	1357396.74	135739.674
17	1036.11533	72.266	5666.33288	679959.945	67995.9945	56663.3288	11563.0471	518057.667	10839.9	1345079.88	134507.988
18	1065.68232	72.266	5783.01983	693962.379	69396.2379	57830.1983	11893.0147	532841.162	10839.9	1376762.89	137676.289
19	1022.25339	72.266	5614.80097	673776.117	67377.6117	56148.0097	11408.3479	511126.696	10839.9	1330676.68	133067.668
20	1022.08459	72.266	5613.13594	673576.312	67357.6312	56131.3594	11406.464	511042.293	10839.9	1330353.96	133035.396
27	1113.81515	72.266	5960.68386	715282.063	71528.2063	59606.8386	12430.1771	556907.575	10839.9	1426594.76	142659.476
29	1011.16354	72.266	5571.1003	668532.036	66853.2036	55711.003	11284.5851	505581.768	10839.9	1318802.5	131880.25
30	1025.09275	72.266	5624.8183	674978.196	67497.8196	56248.183	11440.0351	512546.375	10839.9	1333550.51	133355.051
33	1159.46839	72.266	6142.95658	737154.79	73715.479	61429.5658	12939.6673	579734.196	10839.9	1475813.6	147581.36
37	1039.7894	72.266	5684.17247	682100.696	68210.0696	56841.7247	11604.0497	519894.7	10839.9	1349491.14	134949.114
38	1084.38819	72.266	5853.4098	702409.176	70240.9176	58534.098	12101.7722	542194.097	10839.9	1396319.96	139631.996
39	969.002511	72.266	5406.39149	648766.979	64876.6979	54063.9149	10814.068	484501.255	10839.9	1273862.82	127386.282
40	950.634076	72.266	5335.45756	640254.907	64025.4907	53354.5756	10609.0763	475317.038	10839.9	1254400.99	125440.099
42	1040.95548	72.266	5685.44988	682253.985	68225.3985	56854.4988	11617.0631	520477.74	10839.9	1350268.59	135026.859
47	1576.21792	144.532	9382.9435	1125953.22	112595.322	93829.435	17590.5919	788108.958	21679.8	2159757.33	215975.733
48	1565.74771	144.532	9334.33141	1120119.77	112011.977	93343.3141	17473.7444	782873.854	21679.8	2147502.46	214750.246
49	1205.58048	72.266	6320.86922	758504.307	75850.4307	63208.6922	13454.2781	602790.238	10839.9	1524647.85	152464.785
Avrg:	1113.64402	79.8729474	6137.22104	736466.525	73646.6525	61372.2104	12428.2672	556822.009	11980.942	1452716.61	145271.661
Total:	21159.2363	1517.586	116607.2	13992864	1399286.4	1166072	236137.078	10579618.2	227637.9	27601615.5	2905433.21

§ A2.31 | Turf Wall Milecastles: Dimensions and Volumes

Dimensions

Name	Wall	Length	Base Width	Wall Vol 1	Wall Vol2	Portal	Portal Vol	Source	Notes	
50TW	North	16.76	6.1	206.98	238.42	3.66		CW2, 35.		28.96
	South	16.76	6.1	214.248	246.792	3.2				
	East	32.31	6.1	510.498	588.042	0				
	West	32.31	6.1	510.498	588.042	0				
79TW	North	14.71	5.79	176.9988	204.983	3.05		CW2, 52		26.29
	South	14.71	5.79	176.9988	204.983	3.05				
	East	23.9	5.79	362.802	420.162	0				
	West	23.9	5.79	362.802	420.162	0				

Towers

Name	Source	N. Width	N. Length	S. Width	S. Length	N. Area	S. Area	Notes
50 TW	CW(2), 35, 1	4.27	3.66	3.2	3.66	15.6282	11.712	
79 TW	CW(2), 52, 1	5.79	3.81	5.79	3.96	22.0599	22.9284	Scaled from digram

Volume Turf

Name	Vol 1	Vol2	Num Turf 1	Num Turf 2
50TW	1442.224	1661.296	48074.1333	55376.5333
79TW	1079.6016	1250.29	35986.72	41676.32

Timber Type 1

Name	Substructure	Parapet	Access Steps	Rampart Wlk	G/Ways	Barrack Block	Notes
50TW	0.80764544	6.3791	19.98	6.8698	42.4	120	Substruc1, access2, split poles and 6 access ways are presumed
79TW	0.6045769	5.0193	19.98	5.4054	42.4	120	Substruc1, access2, split poles and 6 access ways are presumed

Timber Type 2

Name	Substructure	Parapet	Access Steps	Rampart Wlk	G/Ways	Barrack Block	Notes
50TW	0.93032576	6.3791	19.98	11.7768	42.4	120	Substruc1, access2, split poles and 6 access ways are presumed
79TW	0.70016218	5.0193	19.98	9.2664	42.4	120	Substruc1, access2, split poles and 6 access ways are presumed

§ A2.32 | Turf Wall Milecastles: Labour

Workrate	Type1										
Structure	Basic Vol I	Turf Num I	Turf Cutting	Haulage	Laying	Core Haulage	P'Pet	Access	Rampart	G/Way	Barrack Block
mc50 TW	1442.224	48074.13	1092.59394	222.195107	1092.59	111.097553	31.90915	510	36.4099	123	1170.92
mc79 TW	1079.6016	35986.72	817.88	166.327972	817.88	83.1639859	24.97001	510	28.6486	123	1170.92

	Type 2										
Structure	Basic Vol 2	Turf Num 2	Turf Cutting	Haulage	Laying	Core Haulage	P'Pet	Access	Rampart	G/Way	Barrack Block
mc50 TW	1661.296	55376.53	1258.55758	255.946262	1258.56	127.973131	32.45385	510	104.814	123	1170.92
mc79 TW	1250.2896	41676.32	947.189091	192.624884	947.189	96.3124422	25.39441	510	82.471	123	1170.92

Structure	Total Person	Building Tea	Est. Time
MC50TW 1	4390.67963	12	365.889969
MC79TW 1	3742.75059	12	311.895883
Avrg:	4066.71511		338.892926

Structure	Total Person	Building Tea	Est. Time
MC50TW 2	4842.18192	12	403.51516
MC79TW 2	4095.06088	12	341.255073

§ A2.33 | Turf Wall Milecastles: Quantitative Survey

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Structure	Turf Vol	Timber Vol	Prob Total	Labour	Supervisio	Equipment	Turf	Timber
MC50TW 1	1442.224	196.4365	4390.67963	526881.555	52688.2	43906.7963	57688.96	29465.4818
MC79TW 1	1079.6016	193.4093	3742.75059	449130.071	44913	37427.5059	43184.06	29011.3915
Avrg:	1260.9128	194.9229	4066.71511	488005.813	48800.6	40667.1511	50436.51	29238.4367
Total:	2521.8256	389.8458	8133.43022	976011.626	97601.2	81334.3022	100873	58476.8734

Structure	Cost in £s	Construc Units
MC50TW 1	710630.949	71063.09
MC79TW1	603666.039	60366.6
Avrg:	657148.494	65714.85
Total:	1314296.99	131429.7

§ A2.34 | Turf Milecastles Stone Rebuild: Dimensions

STONE

Dimensions

Name	Wall	Length	Width	Wall Vol	Portal Width	Portal Vol	Notes
52	North	27.51	2.29	218.466	3.66	9.7772325	Wall widths scaled
	South	27.51	2.29	218.466	3.66	9.7772325	
	East	27.97	2.29	256.2052	0		
	West	27.97	2.29	256.2052	0		
53	North	21.95	2.31	177.5004	2.74	7.4168375	Portals scaled
	South	21.95	2.13	163.6692	2.74	6.5414075	
	East	27.76	2.13	236.5152	0		
	West	27.76	2.13	236.5152	0		
54	North	19.51	3.05	197.152	3.35	13.4682563	Scaled
	South	19.51	3.05	197.152	3.35	13.4682563	
	East	28.65	2.59	296.814	0		
	West	28.65	2.59	296.814	0		
72	North	18.94	2.5	155.9	3.35	10.1978188	Average portal width used.
	South	18.94	2.2	133.144	3.81	9.56929125	East/West length a min
	East	12.6	2.2	110.88	0		
	West	12.6	2.2	110.88	0		
73	North	18.49	2.03	124.3172	3.18	7.0274025	North wall width conjecture.
	South	18.49	2.03	124.3172	3.18	7.0274025	Average portal width used
	East	23.11	2.03	187.6532	0		
	West	23.11	2.03	187.6532	0		
79	North	17.53	2.59	146.9048	3.35	10.7329813	Portals scaled
	South	17.53	2.47	135.5536	3.81	11.3952338	
	East	22.59	2.47	223.1892	0		
	West	22.59	2.47	223.1892	0		

§ A2.35 | Turf Milecastles Stone Rebuild: Tower and Gate Volume

MC Pivot-floor joist

Name	Length	Width	Total Vol.
52 North	3.66	2.29	5.112654
52 South	3.66	2.29	5.112654
53 North	2.74	2.31	3.860934
53 South	2.74	2.13	3.560082
54 North	3.35	3.05	6.232675
54 South	3.35	3.05	6.232675
72 North	3.35	2.5	5.10875
72 South	3.81	2.2	5.11302
73 North	3.18	2.03	3.937794
73 South	3.18	2.03	3.937794
79 North	3.35	2.59	5.292665
79 South	3.81	2.47	5.740527

MC Towers

Name	Source	N. Width	N. Length	S. Width	S. Length	N. Area	S. Area	Notes
51	CW(2), 35, 1	0	0	5.79	3.81	0	22.0599	Scaled
52	CW(2), 35, 1	4.27	3.66	6.25	4.27	15.6282	26.6875	
53	CW(2), 33, 1	6.1	3.35	6.1	3.35	20.435	20.435	Scaled
54	CW(2), 34, 1	5.79	3.35	5.79	3.35	19.3965	19.3965	Scaled
79	CW(2), 52, 1	5.48	3.93	5.79	4.57	21.5364	26.4603	
					Avrg:	19.249025	23.00784	

§ A2.36 | Turf Milecastles Stone Rebuild: Tower Volumes

Towers

Name	Tower	Type 1 Tap	Type 2 Tap	Type 3 Tap
51	South	53.16921	67.34421	81.51921
52	North	44.45181	56.37231	68.29281
	South	52.38621	66.35871	88.80561
53	North	52.38621	64.32201	80.33121
	South	52.38621	66.35871	80.33121
54	North	50.76801	64.32201	77.87601
	South	50.76801	64.32201	77.87601
79	North	52.17741	66.09591	80.01441
	South	57.13641	72.33741	87.53841
	Avrg:	51.73661	65.31481	80.28721

§ A2.37 | Turf Milecastles Stone Rebuild: Volumes

Volumes

Number	Reference	Basic Vol	Tower Vol	Gateway Vol.	Barrack S Vol	Barrack T Vol	Total Stone V	Notes	2 Typ2 Tower
52	CW(2), 35, 1	949.3424	96.83802	29.779773	625.208454	144.532	1701.16865	2 barracks	
53	CW(2), 33, 1	814.2	104.77242	21.379261	312.604227	72.266	1252.95591		
54	CW(2), 35, 1	987.932	101.53602	39.4018625	312.604227	72.266	1441.47411		
72	CW(2), 94, 1	510.804	103.47322	29.98888	312.604227	72.266	956.870327		
73	CW(2), 52, 1	623.9408	103.47322	21.930393	312.604227	72.266	1061.94864		
79	CW(2), 52, 1	728.8368	109.31382	33.161407	312.604227	72.266	1183.91625		

§ A2.38 | Turf Milecastles Stone Rebuild: Labour

Overall Workrate For MCs

Stone MC		Haulage		Building		Mortar				
Number	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold	Barrack Block
52	1701.16865	2268.22486	680.467459	125.88648	251.77296	4286.94499	8573.88998	1339.67031	176.563199	3247.19061
53	1252.95591	1670.60788	501.182363	92.7187372	185.437474	3157.44889	6314.89778	986.702778	146.960043	1623.59531
54	1441.47411	1921.96548	576.589644	106.669084	213.338168	3632.51476	7265.02951	1135.16086	159.462109	1623.59531
72	956.870327	1275.8271	382.748131	70.8084042	141.616808	2411.31322	4822.62645	753.535383	123.915425	1623.59531
73	1061.94864	1415.93152	424.779456	78.5841994	157.168399	2676.11057	5352.22115	836.284554	131.796298	1623.59531
79	1183.91625	1578.55501	473.566502	87.6098028	175.219606	2983.46896	5966.93792	932.33405	144.078869	1623.59531

Number	Prob Total	Est.Build Tea	Comp. Time
52	9856.72305	12	821.393587
53	6508.60812	12	542.38401
54	7233.99176	12	602.832647
72	5365.91587	12	447.159656
73	5771.15039	12	480.929199
79	6244.65349	12	520.387791
Avrg:	6830.17378		569.181148

§ A2.39 | Turf Milecastles Stone Rebuild: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Number	Stone Vol	Timber Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Timber	Cost in £'s	Construc. Units
52	1701.16865	144.532	9856.72305	1182806.77	118280.677	98567.2305	18985.0421	850584.324	21679.8	2290903.84	229090.384
53	1252.95591	72.266	6508.60812	781032.974	78103.2974	65086.0812	13982.9879	626477.954	10839.9	1575523.19	157552.319
54	1441.47411	72.266	7233.99176	868079.011	86807.9011	72339.9176	16086.8511	720737.055	10839.9	1774890.64	177489.064
72	956.870327	72.266	5365.91587	643909.905	64390.9905	53659.1587	10678.6729	478435.164	10839.9	1261913.79	126191.379
73	1061.94864	72.266	5771.15039	692538.046	69253.8046	57711.5039	11851.3468	530974.32	10839.9	1373168.92	137316.892
79	1183.91625	72.266	6244.65349	749358.419	74935.8419	62446.5349	13212.5054	591958.127	10839.9	1502751.33	150275.133
Total:	7598.33389	505.862	40981.0427	4917725.12	491772.512	409810.427	84797.4062	3799166.94	75879.3	9779151.71	977915.171
Avrg:	1266.38898	84.3103333	6830.17378	819620.853	81962.0853	68301.7378	14132.901	633194.491	12646.55	1629858.62	162985.862

§ A2.40 | Stone Wall Forts: Dimensions and Wall Volumes

Dimensions

Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol	Rampart Bac	Notes
Wallsend	North	119.79	1.8	848.7612	7.52	13.54822	3.97	
	South	119.79	1.68	793.30608	7.36	11.69228	4.15	
	East	141.55	1.7	957.7596	7.41	12.0347663	4.1	
	West	141.55	1.84	1010.46498	10.79625	20.2173277	4	Avrg portal width + Porta Quin width (3.18)
Newcastle	North	66	1.7	416.859975	7.61625	12.369742	4.67666667	Portal avrg used; rampart back avrg used
	South	66	1.7	416.859975	7.61625	12.369742	4.67666667	Portal avrg used; rampart back avrg used
	East	114.4	1.7	762.435975	7.61625	12.369742	4.67666667	Portal avrg used; rampart back avrg used
	West	114.4	1.7	762.435975	7.61625	12.369742	4.67666667	Portal avrg used; rampart back avrg used
Benwell	North	128.02	1.52	768.65754	7.61625	9.93635016	4.57	Portal avrg used
	South	128.02	1.52	768.65754	7.61625	9.93635016	4.57	Portal avrg used
	East	179.82	1.52	1099.34874	7.61625	9.93635016	4.57	Portal avrg used
	West	179.82	1.52	1080.83514	10.51625	13.7197627	4.57	Avrg portal width + Porta Quin width (2.9)
Rudchester	North	117.35	1.52	700.54026	7.61625	9.93635016	3.96	Portal avrg used
	South	117.35	1.52	715.26336	5.31	6.92755875	3.96	
	East	160.01	1.52	974.77752	7.31928571	9.54892313	3.96	Portal avrg used
	West	160.01	1.52	968.96352	8.23	10.7370638	3.96	
Halton Chest	North	124.97	1.83	894.95784	8.53	15.8220838	4.42	
	South	124.97	2.13	1052.50329	7.31928571	17.4738797	4.42	Portal avrg used
	East	144.17	1.83	1047.2175	7.92	14.69061	4.42	
	West	144.17	1.83	1044.83484	8.23	15.2656213	4.42	
Chesters	North	132.28	1.52	792.12672	8.2	10.697925	4.75	Portal avrg used; rampart back calculated from turrets
	South	132.28	1.52	791.9352	8.23	10.7370638	4.75	Rampart back calculated from turrets
	East	180.43	1.52	1096.89888	8.61	11.2328213	4.75	Rampart back calculated from turrets
	West	180.43	1.52	1099.3248	8.23	10.7370638	4.75	Rampart back calculated from turrets
Carrawburgh	North	111.56	1.68	735.52248	7.31928571	11.6276003	4.67666667	Portal avrg used; rampart back avrg used
	South	111.56	1.68	735.52248	7.31928571	11.6276003	4.67666667	Portal avrg used; rampart back avrg used
	East	143.57	1.68	961.38504	7.31928571	11.6276003	4.67666667	Portal avrg used; rampart back avrg used
	West	143.57	1.68	961.38504	7.31928571	11.6276003	4.67666667	Portal avrg used; rampart back avrg used
Housesteads	North	185.93	1.3	975.2106	7.32	6.691395	5.8	
	South	185.93	1.3	975.2106	7.32	6.691395	6.15	Rampart back avrg of rest of fort
	East	114.46	1.3	583.3464	7.62	6.9656325	6.5	
	West	114.46	1.3	587.496	6.86	6.2708975	6.15	Rampart back avrg of rest of fort
Great Cheste	North	127.71	1.52	768.57432	7.31928571	9.54892313	4.21	Portal avrg used; Rampart back calculated from turrets
	South	127.71	1.52	769.5912	7.16	9.341115	4.21	Rampart back calculated from turrets
	East	185.24	1.52	1135.84584	7.31928571	9.54892313	4.21	Portal avrg used; Rampart back calculated from turrets
	West	185.24	1.52	1130.03184	8.23	10.7370638	4.21	Rampart back calculated from turrets
Avrg:				866.245786	7.61625	11.2948079	4.67666667	

§ A2.41 | Stone Wall Forts: Pivot-Floor Joist Volume

Name	Wall	Length	Width	Total Vol.
Wallsend	North	7.52	1.8	8.25696
	South	7.36	1.68	7.542528
	East	7.41	1.7	7.68417
	West	10.79625	1.84	12.117711
Newcastle	North	7.61625	1.7	7.89805125
	South	7.61625	1.7	7.89805125
	East	7.61625	1.7	7.89805125
	West	7.61625	1.7	7.89805125
Benwell	North	7.61625	1.52	7.061787
	South	7.61625	1.52	7.061787
	East	7.61625	1.52	7.061787
	West	10.51625	1.52	9.750667
Rudchester	North	7.61625	1.52	7.061787
	South	5.31	1.52	4.923432
	East	7.31928571	1.52	6.78644171
	West	8.23	1.52	7.630856
Halton Chest	North	8.53	1.83	9.522039
	South	7.31928571	2.13	9.50994793
	East	7.92	1.83	8.841096
	West	8.23	1.83	9.187149
Chesters	North	8.2	1.52	7.60304
	South	8.23	1.52	7.630856
	East	8.61	1.52	7.983192
	West	8.23	1.52	7.630856
Carrawburgh	North	7.31928571	1.68	7.500804
	South	7.31928571	1.68	7.500804
	East	7.31928571	1.68	7.500804
	West	7.31928571	1.68	7.500804
Housesteads	North	7.32	1.3	5.80476
	South	7.32	1.3	5.80476
	East	7.62	1.3	6.04266
	West	6.86	1.3	5.43998
Great Cheste	North	7.31928571	1.52	6.78644171
	South	7.16	1.52	6.638752
	East	7.31928571	1.52	6.78644171
	West	8.23	1.52	7.630856

§ A2.42 | Stone Wall Forts: Turret Dimension and Volume

Fort	Turret	Wall	Length	Width	Portal Size	Type 1 Tap	Type 2 Tap	Type 3 Tap
Wallsend	N G/way. E.	North	2.79	1.13	0	21.15378	23.03703	24.92028
		South	2.79	1.05	0	20.1717	22.05495	23.9382
		East	5.45	1.04	0	39.1637	42.84245	46.5212
		West	5.45	1.04	0.8648	37.5717762	41.2505262	44.9292762
	N G/Way. W.	North	2.81	1.13	0	21.30542	23.20217	25.09892
		South	2.81	1.04	0	20.19266	22.08941	23.98616
		East	5.42	1.05	0.8648	37.5793692	41.2378692	44.8963692
		West	5.42	1.1	0	40.379	44.0375	47.696
	E G/Way. N.	North	3.17	1.32	0	26.68506	28.82481	30.96456
		South	3.17	1.4	0.8648	25.6579256	27.7976756	29.9374256
		East	5.35	1.3	0	44.5655	48.17675	51.788
		West	5.35	1.25	0	43.3885	46.99975	50.611
	E G/Way. S.	North	3.04	1.37	0.8648	24.1624665	26.2144665	28.2664665
		South	3.04	1.38	0	26.39328	28.44528	30.49728
		East	5.4	1.32	0	45.4572	49.1022	52.7472
		West	5.4	1.29	0	44.7444	48.3894	52.0344
	S G/Way. E.	North	2.55	1.37	0	22.0269	23.74815	25.4694
		South	2.55	1.38	0	22.1391	23.86035	25.5816
		East	5.79	1.32	0	48.74022	52.64847	56.55672
		West	5.79	1.29	0.8648	46.0013422	49.9095922	53.8178422
	S G/Way. W.	North	2.55	1.4	0	22.3635	24.08475	25.806
		South	2.55	1.37	0	22.0269	23.74815	25.4694
		East	5.83	1.37	0.8648	48.2624865	52.1977365	56.1329865
		West	5.83	1.43	0	51.89866	55.83391	59.76916
	ES Interval	North	2.96	1.4	0	25.9592	27.9572	29.9552
		South	2.96	1.37	0	25.56848	27.56648	29.56448
		East	5.56	1.37	0	48.02728	51.78028	55.53328
		West	5.56	1.43	0.8648	47.3062247	51.0592247	54.8122247
	SE Angle	North	3.48	1.45	0.8648	29.0656908	31.4146908	33.7636908
		South	3.48	1.41	0	30.67272	33.02172	35.37072
		East	6.36	1.45	0	57.1764	61.4694	65.7624
		West	6.36	1.44	0	56.89656	61.18956	65.48256
	SE Interval	North	2.99	1.26	0.8648	22.451783	24.470033	26.488283
		South	2.99	1.36	0	25.69606	27.71431	29.73256
		East	5.64	1.32	0	47.47752	51.28452	55.09152
		West	5.64	1.3	0	46.9812	50.7882	54.5952
	SW Interval	North	3.01	1.4	0.8648	24.2547256	26.2864756	28.3182256
		South	3.01	1.36	0	25.86794	27.89969	29.93144
		East	5.77	1.32	0	48.57186	52.46661	56.36136
		West	5.77	1.39	0	50.34902	54.24377	58.13852
	SW Angle	North	3.41	1.38	0.8648	27.4932595	29.7950095	32.0967595
		South	3.41	1.42	0	30.20578	32.50753	34.80928
		East	6.2	1.45	0	55.738	59.923	64.108
		West	6.2	1.37	0	53.5556	57.7406	61.9256

	NE Angle	North	3.56	1.5	0	32.7876	35.1906	37.5936
		South	3.56	1.06	0.8648	24.2729022	26.6759022	29.0789022
		East	6.13	1.06	0	44.58962	48.72737	52.86512
		West	6.13	1.04	0	44.05018	48.18793	52.32568
	NE Interval	North	3.26	1.64	0	32.03276	34.23326	36.43376
		South	3.26	1.04	0.8648	21.8344362	24.0349362	26.2354362
		East	5.49	1.04	0	39.45114	43.15689	46.86264
		West	5.49	1.04	0	39.45114	43.15689	46.86264
	NW Interval	North	2.26	1.58	0	21.61012	23.13562	24.66112
		South	2.26	1.05	0.8648	14.7325692	16.2580692	17.7835692
		East	6.08	1.04	0	43.69088	47.79488	51.89888
		West	6.08	1.04	0	43.69088	47.79488	51.89888
	NW Angle	North	3.6	1.43	0	32.0472	34.4772	36.9072
		South	3.6	1.1	0.8648	25.1362344	27.5662344	29.9962344
		East	6.08	1.05	0	43.9584	48.0624	52.1664
		West	6.08	1.05	0	43.9584	48.0624	52.1664
Benwell	SE Angle	North	2.97	1.52	1.03	24.843948	26.848698	28.853448
		South	2.97	1.52	0	27.61506	29.61981	31.62456
		East	5.48	1.52	0	50.95304	54.65204	58.35104
		West	5.48	1.52	0	50.95304	54.65204	58.35104
Rudchester	S G/way, W.	North	3.35	1.14	0.69	24.154818	26.416068	28.677318
		South	3.35	1.14	0	25.5471	27.80835	30.0696
		East	5.49	0.76	0	32.68746	36.39321	40.09896
		West	5.49	0.61	0	29.06406	32.76981	36.47556
	S G/way, E.	North	3.05	0.76	0	18.1597	20.21845	22.2772
		South	3.05	1.07	0	22.3199	24.37865	26.4374
		East	5.49	0.84	0	34.61994	38.32569	42.03144
		West	5.49	0.61	0.69	28.319067	32.024817	35.730567
	W G/Way, N.	North	4.42	0.76	0	26.31668	29.30018	32.28368
		South	4.42	0.84	0.61	26.965572	29.949072	32.932572
		East	4.8	0.76	0	28.5792	31.8192	35.0592
		West	4.8	0.84	0	30.2688	33.5088	36.7488
	W G/Way, S.	North	4.42	0.76	0.61	25.496108	28.479608	31.463108
		South	4.42	0.84	0	27.87252	30.85602	33.83952
		East	4.8	0.76	0	28.5792	31.8192	35.0592
		West	4.8	0.76	0	28.5792	31.8192	35.0592

Halton Chest	W G/Way, N.	North	4.57	0.86	0	29.22058	32.30533	35.39008	
		South	4.57	1.14	0.8648	33.1058266	36.1905766	39.2753266	
		East	3.94	0.86	0	25.19236	27.85186	30.51136	
		West	3.94	1.09	0	29.17964	31.83914	34.49864	
	E G/Way, N.	North	3.81	0.91	0	25.19934	27.77109	30.34284	
		South	3.81	1.22	0.8648	28.5287309	31.1004809	33.6722309	
		East	4.72	1.37	0	40.77136	43.95736	47.14336	
		West	4.72	1.22	0	37.65616	40.84216	44.02816	
Chesters	S G/way, E.	North	3.2	0.86	0	20.4608	22.6208	24.7808	
		South	3.2	0.86	0	20.4608	22.6208	24.7808	
		East	5.62	0.86	0	35.93428	39.72778	43.52128	
		West	5.62	0.86	0.76	34.777408	38.570908	42.364408	
	S G/way, W.	North	3.2	0.91	0	21.1648	23.3248	25.4848	
		South	3.2	0.86	0	20.4608	22.6208	24.7808	
		East	5.67	0.86	0.76	35.097108	38.924358	42.751608	
		West	5.67	0.76	0	33.75918	37.58643	41.41368	
	N G/way. E.	North	3.47	0.91	0	22.95058	25.29283	27.63508	
		South	3.47	0.94	0	23.40862	25.75087	28.09312	
		East	5.62	0.95	0.7	36.98275	40.77625	44.56975	
		West	5.62	0.93	0	37.66524	41.45874	45.25224	Wall width avrg of other three
	N G/Way. W.	North	3.45	1.08	0	25.3989	27.72765	30.0564	
		South	3.45	0.95	0	23.4255	25.75425	28.083	
		East	5.85	0.94	0	39.4641	43.41285	47.3616	
		West	5.85	1.04	0.73	40.694316	44.643066	48.591816	
	W G/Way, N.	North	3.76	0.98	0	26.02672	28.56472	31.10272	
		South	3.76	0.94	0.77	24.083834	26.621834	29.159834	
		East	5.66	1.03	0	40.42372	44.24422	48.06472	
		West	5.66	1.01	0	39.92564	43.74614	47.56664	
	W G/Way, S.	North	3.78	0.97	0.64	24.900024	27.451524	30.003024	
		South	3.78	0.985	0	26.24832	28.79982	31.35132	
		East	5.605	0.99	0	39.04443	42.827805	46.61118	
		West	5.605	0.98	0	38.79781	42.581185	46.36456	
	SE Angle	North	3.5	0.79	0.78	20.210326	22.572826	24.935326	
		South	3.5	1.58	0	33.467	35.8295	38.192	
		East	6.37	0.825	0	39.7488	44.04855	48.3483	
		West	6.37	0.79	0	38.76782	43.06757	47.36732	
	SE Interval	North	3.84	0.76	0.71	21.908268	24.500268	27.092268	
		South	3.84	1.54	0	36.04224	38.63424	41.22624	
		East	5.16	0.78	0	31.17672	34.65972	38.14272	
		West	5.16	0.765	0	30.83616	34.31916	37.80216	
	SW Interval	North	3.3	0.79	0.58	19.272786	21.500286	23.727786	
		South	3.3	1.67	0	32.8614	35.0889	37.3164	
		East	5.36	0.8	0	32.8568	36.4748	40.0928	
		West	5.36	0.82	0	33.32848	36.94648	40.56448	

Housesteads	N G/Way, E.	North	2.13	1.52	0	19.80474	21.24249	22.68024
		South	2.13	1.07	0	15.58734	17.02509	18.46284
		East	5.79	1.16	0.91	42.795648	46.703898	50.612148
		West	5.79	1.16	0	44.66406	48.57231	52.48056
	N G/Way, W.	North	2.23	1.52	0	20.73454	22.23979	23.74504
		South	2.23	1.16	0	17.20222	18.70747	20.21272
		East	5.89	1.16	0	45.43546	49.41121	53.38696
		West	5.89	1.16	0.91	43.567048	47.542798	51.518548
	E G/Way, N.	North	4.27	1.07	0	31.24786	34.13011	37.01236
		South	4.27	1.16	1.07	30.741856	33.624106	36.506356
		East	5.53	1.52	0	51.41794	55.15069	58.88344
		West	5.53	0.91	0	36.57542	40.30817	44.04092
	E G/Way, S.	North	3.66	1.07	0.91	25.060431	27.530931	30.001431
		South	3.66	1.22	0	29.19948	31.66998	34.14048
		East	5.03	1.52	0	46.76894	50.16419	53.55944
		West	5.03	1.07	0	36.80954	40.20479	43.60004
	S G/way, E.	North	2.59	1.16	0	19.97926	21.72751	23.47576
		South	2.59	1.52	0	24.08182	25.83007	27.57832
		East	6.34	1.16	0	48.90676	53.18626	57.46576
		West	6.34	1.16	0.91	47.038348	51.317848	55.597348
	S G/way, W.	North	2.74	1.16	0	21.13636	22.98586	24.83536
		South	2.74	1.52	0	25.47652	27.32602	29.17552
		East	6.34	1.16	0.91	47.038348	51.317848	55.597348
		West	6.34	1.16	0	48.90676	53.18626	57.46576
	W G/Way, N.	North	3.81	0.91	0	25.19934	27.77109	30.34284
		South	3.81	1.07	0.76	26.442216	29.013966	31.585716
		East	4.57	0.91	0	30.22598	33.31073	36.39548
		West	4.57	0.91	0	30.22598	33.31073	36.39548
	W G/Way, S.	North	3.81	0.91	0.76	23.975208	26.546958	29.118708
		South	3.81	1.07	0	27.88158	30.45333	33.02508
		East	4.57	0.91	0	30.22598	33.31073	36.39548
		West	4.57	0.91	0	30.22598	33.31073	36.39548
	NE Angle Ori	North	3.66	1.52	0	34.03068	36.50118	38.97168
		South	3.66	0.84	0.91	21.726972	24.197472	26.667972
		East	5.18	0.84	0	32.66508	36.16158	39.65808
		West	5.18	0.84	0	32.66508	36.16158	39.65808
	NE Angle Rep	North	3.2	1.52	0	29.7536	31.9136	34.0736
		South	3.2	0.86	0.76	19.303928	21.463928	23.623928
		East	5.28	0.86	0	33.76032	37.32432	40.88832
		West	5.28	0.86	0	33.76032	37.32432	40.88832

	NW Angle	North	3.66	1.52	0	34.03068	36.50118	38.97168
		South	3.66	0.86	0.86	22.092948	24.563448	27.033948
		East	5.89	0.86	0	37.66066	41.63641	45.61216
		West	5.89	0.86	0	37.66066	41.63641	45.61216
	E wall, N. int	North	2.59	1.16	0	19.97926	21.72751	23.47576
		South	2.59	1.16	0	19.97926	21.72751	23.47576
		East	4.93	1.52	0	45.83914	49.16689	52.49464
		West	4.93	1.07	1.07	34.051267	37.379017	40.706767
	SE Angle	North	4.42	1.16	0	34.09588	37.07938	40.06288
		South	4.42	1.52	0.8648	38.7705021	41.7540021	44.7375021
		East	5.89	0.71	0	33.77326	37.74901	41.72476
		West	5.89	0.71	0	33.77326	37.74901	41.72476
	SW Angle	North	4.11	1.16	1.22	29.199636	31.973886	34.748136
		South	4.11	1.52	0	38.21478	40.98903	43.76328
		East	5.23	1.16	0	40.34422	43.87447	47.40472
		West	5.23	1.16	0	40.34422	43.87447	47.40472
	S wall, int.	North	3.96	1.16	0.91	28.679028	31.352028	34.025028
		South	3.96	1.52	0	36.82008	39.49308	42.16608
		East	5.74	1.16	0	44.27836	48.15286	52.02736
		West	5.74	1.16	0	44.27836	48.15286	52.02736
Great Cheste	S G/way, E.	North	3.05	1.16	0	23.5277	25.58645	27.6452
		South	3.05	0.91	0	20.1727	22.23145	24.2902
		East	5.13	0.91	0.8648	32.5368866	35.9996366	39.4623866
		West	5.13	1.16	0	39.57282	43.03557	46.49832
	W G/Way, N.	North	3.81	1.07	0	27.88158	30.45333	33.02508
		South	3.81	0.76	0.76	21.662388	24.234138	26.805888
		East	4.72	1.12	0	35.57936	38.76536	41.95136
		West	4.72	0.96	0	32.25648	35.44248	38.62848
	W G/Way, S.	North	3.96	0.86	0.61	24.391698	27.064698	29.737698
		South	3.96	1.07	0	28.97928	31.65228	34.32528
		East	3.45	1.12	0	26.0061	28.33485	30.6636
		West	3.45	1.07	0	25.2471	27.57585	29.9046
	NW Angle	North	3.1	2.13	0	37.1442	39.2367	41.3292
		South	3.1	1.07	1.07	20.659327	22.751827	24.844327
		East	6.3	1.16	0	48.5982	52.8507	57.1032
		West	6.3	1.07	0	46.1034	50.3559	54.6084
	SW Angle	North	3.63	1.07	1.16	24.367416	26.817666	29.267916
		South	3.63	1.52	0	33.75174	36.20199	38.65224
		East	5.69	1.16	0	43.89266	47.73341	51.57416
		West	5.69	0.91	0	37.63366	41.47441	45.31516
Avrg:					0.8648	37.9403216	41.4042605	44.8681994

§ A2.43 | Stone Wall Forts: Rampart Backing Volume

Rampart Backing

Fort	Wall	Rampart Back Vol.
Wallsend	North	998.68923
	South	1043.96985
	East	1218.7455
	West	1189.02
Newcastle	North	648.186
	South	648.186
	East	1123.5224
	West	1123.5224
Benwell	North	1228.60794
	South	1228.60794
	East	1725.73254
	West	1725.73254
Rudchester	North	975.8826
	South	975.8826
	East	1330.64316
	West	1330.64316
Halton Chest	North	1159.97154
	South	1159.97154
	East	1338.18594
	West	1338.18594
Chesters	North	1319.493
	South	1319.493
	East	1799.78925
	West	1799.78925
Carrawburgh	North	1095.63076
	South	1095.63076
	East	1410.00097
	West	1410.00097
Housesteads	North	2264.6274
	South	2401.28595
	East	1562.379
	West	1478.2509
Great Cheste	North	1129.08411
	South	1129.08411
	East	1637.70684
	West	1637.70684
Avrg:		1333.3845

§ A2.44 | Stone Wall Forts: Total Fort Volume

Name	Reference	Basic Vol	Turret Vol.	Gateway Vol.	Total StoneV	Total Turf Vol	
Wallsend		3610.29186	2197.63978	93.0939629	5901.02561	4450.42458	For E G/way turrets: averages of other G/Way turrets used.
Newcastle		2358.5919	1571.17567	81.0711731	4010.83874	3543.4168	12 Turrets presumed, averages used for 12.
Benwell		3717.49896	1594.60945	74.4648411	5386.57325	5908.68096	12 Turrets presumed, averages used for 11.
Rudchester		3359.54466	1484.97977	63.5524125	4908.07684	4613.05152	12 Turrets presumed, averages used for 8
Halton Chesters		4039.51347	1558.16706	100.312427	5697.99295	4996.31496	12 Turrets presumed, averages used for 10.
Chesters		3780.2856	2542.27685	74.2528178	6396.81526	6238.5645	20 Turrets presumed, averages used for 11.
Carrawburgh		3393.81504	1833.03828	76.5136171	5303.36694	5011.26346	14 Turrets presumed, averages used for 14
Housesteads		3121.2636	2459.53956	49.71148	5630.51464	7706.54325	20 Turrets presumed, averages used for 6.
Great Chesters		3804.0432	1546.48384	67.0185164	5417.54555	5533.5819	12 Turrets presumed, averages used for 7.

§ A2.45 | Stone Wall Forts: Labour

Workrates

Stone		Haulage		Building		Mortar			
Name	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold
Wallsend	5901.02561	7868.03414	2360.41024	534.63292	1069.26584	12911.444	25822.888	4034.82626	987.81792
Newcastle	4010.83874	5347.78499	1604.3355	363.38199	726.76398	8775.71517	17551.4303	2742.41099	715.84114
Benwell	5386.57325	7182.09767	2154.6293	488.023537	976.047074	11785.8223	23571.6446	3683.06946	813.20838
Rudchester	4908.07684	6544.10246	1963.23074	444.671762	889.343524	10738.8721	21477.7443	3355.89754	735.67486
Halton Chest	5697.99295	7597.32394	2279.19718	516.238162	1032.47632	12467.2086	24934.4172	3896.00268	821.02369
Chesters	6396.81526	8529.08702	2558.72611	579.551463	1159.10293	13996.2318	27992.4636	4373.82244	1099.5007
Carrawburgh	5303.36694	7071.15592	2121.34678	480.485045	960.97009	11603.7669	23207.5337	3626.17715	879.72336
Housesteads	5630.51464	7507.35285	2252.20585	510.124626	1020.24925	12319.566	24639.132	3849.86438	1084.9548
Great Cheste	5417.54555	7223.39407	2167.01822	490.829627	981.659254	11853.5897	23707.1793	3704.24677	779.76822

Turf Back	Vol	Turf Num	Turf Cutting	Haulage	Laying	Core Haulag	Total Person Days
Wallsend	4450.42458	222521.229	5057.30066	1028.47675	5057.30066	342.825582	11485.9036
Newcastle	3543.4168	177170.84	4026.61	818.870586	4026.61	272.956862	9145.04745
Benwell	5908.68096	295434.048	6714.41018	1365.47443	6714.41018	455.158144	15249.4529
Rudchester	4613.05152	230652.576	5242.104	1066.05923	5242.104	355.353078	11905.6203
Halton Chest	4996.31496	249815.748	5677.63064	1154.63001	5677.63064	384.876669	12894.7679
Chesters	6238.5645	311928.225	7089.27784	1441.7093	7089.27784	480.569768	16100.8348
Carrawburgh	5011.26346	250563.173	5694.61757	1158.08455	5694.61757	386.028183	12933.3479
Housesteads	7706.54325	385327.163	8757.43551	1780.95379	8757.43551	593.651264	19889.4761
Great Cheste	5533.5819	276679.095	6288.16125	1278.79042	6288.16125	426.263473	14281.3764

Name	Prob Total	Buiding Tean	Completion Time
Wallsend	32315.035	608	53.1497286
Newcastle	23346.7322	500	46.6934645
Benwell	34174.2059	512	66.7464959
Rudchester	29143.9674	608	47.9341568
Halton Chest	32874.4382	608	54.0697997
Chesters	38708.6672	500	77.4173344
Carrawburgh	31644.8471	608	52.0474458
Housesteads	39906.1917	800	49.8827397
Great Cheste	33276.8289	480	69.3267269
Avrg:	32821.2126		57.4742103

§ A2.46 | Stone Wall Forts: Scaled-Up Volume

Inchtuthil Ratio Total

Name	Prob Total	Buiding Tean	Completion Time
Wallsend	122891.875	608	202.124794
Newcastle	83789.9403	500	167.579881
Benwell	111656.042	512	218.078208
Rudchester	101706.248	608	167.280012
Halton Chest	117880.055	608	193.881669
Chesters	133386.211	500	266.772423
Carrawburgh	110397.845	608	181.575403
Housesteads	118098.622	800	147.623278
Great Cheste	112073.17	480	233.48577
Avrg:	112431.112		197.60016

§ A2.47 | Stone Wall Forts: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name	Stone Vol	Turf Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Turf	Timber	Stone	Cost in £'s	Construc. Units
Wallsend	5901.02561	4450.42458	32315.035	3877804.2	387780.42	323150.35	64557.2201	178016.983	0	2950512.8	7781821.977	778182.198
Newcastle	4010.83874	3543.4168	23346.7322	2801607.87	280160.787	233467.322	43878.5759	141736.672	0	2005419.37	5506270.598	550627.06
Benwell	5386.57325	5908.68096	34174.2059	4100904.71	410090.471	341742.059	58929.1114	236347.238	0	2693286.63	7841300.215	784130.022
Rudchester	4908.07684	4613.05152	29143.9674	3497276.08	349727.608	291439.674	53694.3607	184522.061	0	2454038.42	6830698.208	683069.821
Halton Chest	5697.99295	4996.31496	32874.4382	3944932.59	394493.259	328744.382	62336.0429	199852.598	0	2848996.48	7779355.349	777935.535
Chesters	6396.81526	6238.5645	38708.6672	4645040.06	464504.006	387086.672	69981.159	249542.58	0	3198407.63	9014562.114	901456.211
Carrawburgh	5303.36694	5011.26346	31644.8471	3797381.65	379738.165	316448.471	58018.8343	200450.538	0	2651683.47	7403721.125	740372.113
Housesteads	5630.51464	7706.54325	39906.1917	4788743.01	478874.301	399061.917	61597.8301	308261.73	0	2815257.32	8851796.106	885179.611
Great Cheste	5417.54555	5533.5819	33276.8289	3993219.47	399321.947	332768.289	59267.9484	221343.276	0	2708772.78	7714693.706	771469.371
Avrg:	5405.86109	5333.53799	32821.2126	3938545.52	393854.552	328212.126	59140.1203	213341.52	0	2702930.54	7636024.378	763602.438
Total:	48652.7498	48001.8419	295390.914	35446909.6	3544690.96	2953909.14	532261.083	1920073.68	0	24326374.9	68724219.4	6872421.94

With Inchtuthil Ratio

Name	Stone Vol	Turf Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Turf	Timber	Stone	Cost in £'s	Con. Units
Wallsend	34816.0511	4450.42458	122891.875	14747025	1474702.5	1228918.75	380887.599	178016.983	0	17408025.5	35417576.37	3541757.64
Newcastle	23663.9486	3543.4168	83789.9403	10054792.8	1005479.28	837899.403	258883.598	141736.672	0	11831974.3	24130766.08	2413076.61
Benwell	31780.7822	5908.68096	111656.042	13398725.1	1339872.51	1116560.42	347681.757	236347.238	0	15890391.1	32329578.13	3232957.81
Rudchester	28957.6534	4613.05152	101706.248	12204749.7	1220474.97	1017062.48	316796.728	184522.061	0	14478826.7	29422432.63	2942243.26
Halton Chest	33618.1584	4996.31496	117880.055	14145606.6	1414560.66	1178800.55	367782.653	199852.598	0	16809079.2	34115682.24	3411568.22
Chesters	37741.2101	6238.5645	133386.211	16006345.4	1600634.54	1333862.11	412888.838	249542.58	0	18870605	38473878.47	3847387.85
Carrawburgh	31289.8649	5011.26346	110397.845	13247741.4	1324774.14	1103978.45	342311.123	200450.538	0	15644932.5	31864188.16	3186418.82
Housesteads	33220.0364	7706.54325	118098.622	14171834.7	1417183.47	1180986.22	363427.198	308261.73	0	16610018.2	34051711.49	3405171.15
Great Cheste	31963.5188	5533.5819	112073.17	13448780.4	1344878.04	1120731.7	349680.895	221343.276	0	15981759.4	32467173.67	3246717.37
Avrg:	31894.5804	5333.53799	112431.112	13491733.5	1349173.35	1124311.12	348926.71	213341.52	0	15947290.2	32474776.36	3247477.64
										Total	292272987.2	29227298.7

§ A2.48 | Turf Wall Forts: Dimensions and Volumes

TURF

Dimensions

Name	Wall	Length	Width	Wall Vol.1	Wall Vol.2	Portal	Portal Vol	Notes
Drumburgh	North	84.73	5.79	1301.89752	1507.73112	3.05		CW2, 52.
|	South	84.73	5.79	1301.89752	1507.73112	3.05		
|	East	82.3	5.79	1263.16575	1462.87575	3.05		
|	West	82.3	5.79	1263.16575	1462.87575	3.05		

Volume

Turf

Name	Vol 1	Vol 2	Num Turf 1	Num Turf 2
Drumburgh	5130.12654	5941.21374	171004.218	198040.458

Timber Type1

Name	Substructure	Parapet	Access Steps	G Ways	Rampart Wal	Notes
Drumburgh	2.87287086	21.7139	59.94	131.6	23.3842	18 access presumed

Type2

Name	Substructure	Parapet	Access Steps	G Ways	Rampart Wal	Notes
Drumburgh	3.32707969	21.7139	59.94	131.6	40.0872	18 access presumed

§ A2.49 | Turf Wall Forts: Labour

Workrate

Turf Type1

Name	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways
Drumburgh	3886.4595	790.368913	3886.4595	395.184456	109.165263	1530	123.93626	359.268

Turf Type2

Name	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways
Drumburgh	4500.9195	915.328425	4500.9195	457.664212	111.18195	1530	356.77608	359.268

Name	Total Person	Build Team	Est. Time
D'burgh Tp1	11080.8419	1000	11.0808419

Name	Total Person	Build Team	Est. Time
D'burgh Tp2	12732.0577	1000	12.7320577

§ A2.50 | Turf Wall Forts: Quantitative Survey

Quantitative Survey

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Fort	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
D'burgh, Tp1	5130.12654	239.510971	11080.8419	1329701.03	132970.103	110808.419	205205.062	35926.6456
D'burgh, Tp2	5941.21374	256.66818	12732.0577	1527846.92	152784.692	127320.577	237648.55	38500.227
Avrg:				1428773.97	142877.397	119064.498	221426.806	37213.4363

Fort	Total Cost	Construc Units
D'burgh, Tp1	1814611.26	181461.126
D'burgh, Tp2	2084100.97	208410.097
Avrg:	1949356.11	194935.611
Total:	3898712.22	389871.222

Inchtuhil Ratio

	Drumburgh I	Drumburgh II
Tot. Pers. D	11080.8419	12732.0577
Inchtuthil fig.	65376.9672	75119.1402
Comp. Time	65.3769672	75.1191402

Fort	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
Drumburgh	5130.12654	1413.11473	65376.9672	7845236.06	784523.606	653769.672	205205.062	211967.209

Total	9700701.61

§ A2.51 | Turf Fort Stone Rebuild: Dimensions

Dimensions

Name	Wall	Length	Width	Wall Vol.	Portal	Portal Vol	Rampart Bac	Rampart Vol	Notes
Stanwix	North	210.31	1.52	1288.86576	8.42	12.6912134	3.7625	1595.18336	Avrg Portal wi
	South	210.31	1.52	1288.86576	8.42	12.6912134	3.7625	1595.18336	Avrg rampart
	East	173.74	1.52	1055.40288	8.42	12.6912134	3.7625	1306.23465	Avrg rampart
	West	173.74	1.52	1055.40288	8.42	12.6912134	3.7625	1306.23465	Avrg rampart
Bowness	North	210	1.4	1187.76	8	11.1062	3	1272.6	All Walls assumed same as west.
	South	210	1.4	1187.76	8	11.1062	3	1272.6	Length Sclaed from diagram
	East	120	1.4	658.56	8	11.1062	3	705.6	Portal Size assumed to match road
	West	120	1.4	658.56	8	11.1062	3	705.6	
C'steads (i)	North	140.83	1.52	842.62416	8.84	13.3242668	4.5	1247.3055	E-W Face presumed.
	South	140.83	1.52	842.62416	8.84	13.3242668	4.5	1247.3055	West wall width used for all others.
	East	120.09	1.52	710.22	8.84	13.3242668	4.5	1051.3125	Portals scaled from diagram.
	West	120.09	1.52	710.22	8.84	13.3242668	4.5	1051.3125	
C'steads (ii)	North	117.05	1.52	690.81264	8.84	13.3242668	4.5	1022.5845	N face presumed.
	South	117.05	1.52	690.81264	8.84	13.3242668	4.5	1022.5845	West wall width used for all.
	East	120.09	1.52	710.22	8.84	13.3242668	4.5	1051.3125	Portals scaled from diagram
	West	120.09	1.52	710.22	8.84	13.3242668	4.5	1051.3125	
Birdoswald	North	121.92	1.6	761.9808	8.53	15.066018	3.05	726.26295	Por width & vol match S
	South	121.92	1.6	761.9808	8.53	13.533698	3.05	726.26295	
	East	179.98	1.6	1128.4896	12.05	16.07341	3.05	1075.59165	PQ added to portal (3.12m)
	West	179.98	1.6	1118.7456	13.5	18.1007	3.05	1066.3044	PQ added to portal (3.4m)
Avrg:							3.7625		

§ A2.52 | Turf Fort Stone Rebuild: Turret Dimensions

Fort	Turret	Wall	Length	Width	Portal Size	Notes
Bowness	W Gate, N	North	3.1	1.4	0	Portal conjectural, scaled from diagram. East and We
		South	3.1	0.8	0	
		East	6.01	0.8	0	
		West	6.01	0.8	1	
C'Steads	W gway, S.	North	3.05	1.52	0	Door avrg used. South, east and west widths scaled f
		South	3.05	0.76	0	
		East	5.33	0.76	1.03	
		West	5.33	0.76	0	
Birdoswald	E gway, N	North	3.35	0.91	0	
		South	3.35	0.91	0	
		East	4.57	1.52	0	
		West	4.57	0.91	0.76	
	E gway, S.	North	3.35	0.91	0	
		South	3.35	0.91	0	
		East	5.49	1.52	0	
		West	5.49	0.91	0.76	
	S gway, E.	North	2.44	0.91	0.76	
		South	2.44	1.52	0	
		East	5.59	0.91	0	
		West	5.59	0.91	0	
	S gway, W.	North	2.44	0.91	0.76	
		South	2.44	1.52	0	
		East	5.59	0.91	0	
		West	5.59	0.91	0	
	W gway, N.	North	3.1	0.9	0	
		South	3.1	1	0	
		East	4.9	1.8	0	
		West	4.9	0.9	0.9	
	W gway, S.	North	3.1	1.1	0	
		South	3.1	1	0	
		East	4.8	1.6	0	
		West	4.8	1	0.8	

NE Angle	North	4.6	1.4	0
	South	4.6	0.95	0.8
	East	5.85	1	0
	West	5.85	0.9	0
SE Angle	North	4.2	0.91	0.76
	South	4.2	1.52	0
	East	5.93	0.91	0
	West	5.93	0.91	0
SW Angle	North	4.2	0.91	0.76
	South	4.2	1.52	0
	East	5.93	0.91	0
	West	5.93	0.91	0
E-N interval	North	3.05	0.91	0
	South	3.05	0.91	0
	East	5.94	1.52	0
	West	5.94	0.91	0.91
W-N Interva	North	2.86	0.935	0
	South	2.86	0.95	0
	East	5.945	0.91	0.9
	West	5.945	1.58	0
SE Angle	North	4.5	0.98	0.8
	South	4.5	1.56	0
	East	6.59	0.98	0
	West	6.59	0.91	0

§ A2.53 | Turf Fort Stone Rebuild: Turret, Rampart & Fort Volume

Volume

Fort Turret Volume

Fort	Turret	Type 1 Tap	Type 2 Tap	Type 3 Tap	Scaffold Wor	Total Scaff W/rate	
Bowness	W G/way N.	111.88	124.18	136.48	33.271503	454.744923	12 presumed, averages used for 11.
C'Steads	W G/way S.	108.6	119.92	131.23	32.296078	453.769498	12 presumed, averages used for 11.
Birdoswald	E g/way N	115.80751	126.499508	137.191508	34.439488	547.484665	14 presumed, averages used for 2.
	E g/way S	130.44655	142.380548	154.314548	38.792928		
	S g/way E	111.54567	122.386168	133.226668	33.172078		
	S g/way W	111.54567	122.386168	133.226668	33.172078		
	W G/way N.	124.4543	135.2543	146.0543	37.010919		
	W G/way S.	123.378	134.043	144.708	36.690843		
	NE Angle	149.6738	163.7813	177.8888	44.510836		
	SE Angle	144.04831	157.723808	171.399308	42.837896		
	SW Angle	144.04831	157.723808	171.399308	42.837896		
	E-N Internal	133.39694	145.533443	157.669943	39.670333		
	W-N Int	133.36673	145.25348	157.14023	39.661348		
	SE Angle	161.59656	176.56806	191.53956	48.056493		
Avrg:		128.84202	140.973828	153.104917	38.315765	454.25721	

Rampart Backing

Fort	Rampart Back Vol.
Stanwix	5802.836
Bowness	3956.4
C'Steads (i)	4597.236
C'Steads (ii)	4147.794
Birdoswald	3594.422

Total Fort Volume

Stone Fort:

Name	Reference	Basic Vol	Turret Vol.	Gateway Vol.	Total StoneVol	
Stanwix	JRS 31, 194	4688.5373	1546.10429	61.72	6296.3616	Turret averages used, 12 presumed
Bowness	CW(2), 75,	3692.64	1529.14227	57.12	5278.9023	
C'steads (i)	CW(2), 34,	3105.6883	1525.86227	64.4	4695.9506	
C'steads (ii)	CW(2), 34,	2802.0653	1546.10429	64.4	4412.5696	
Birdoswald		3771.1968	1847.19306	98.6385727	5717.0284	

§ A2.54 | Turf Fort Stone Rebuild: Labour

Workrates

Stone Fort		Haulage		Building		Mortar			
Name	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold
Stanwix	6296.3616	8395.1488	2518.54463	570.450358	1140.9007	13776.4391	27552.8782	4305.13723	909.529297
Bowness	5278.9023	7038.5364	2111.56091	478.268545	956.53709	11550.2382	23100.4763	3609.44943	831.809371
C'Steads (I)	4695.9506	6261.2675	1878.38024	425.453123	850.90625	10274.7399	20549.4798	3210.85621	789.19454
C'Steads (II)	4412.5696	5883.4261	1765.02783	399.778803	799.55761	9654.70222	19309.4044	3017.09445	768.953039
Birdoswald	5717.0284	7622.7046	2286.81137	517.962776	1035.9256	12508.8582	25017.7164	3909.01819	957.687831

Name	Vol	Turf Num	Turf Cutting	Haulage	Laying	Total Person Days
Stanwix	5802.836	290141.8	6594.13185	1341.01406	6594.1318	14529.2777
Bowness	3956.4	197820	4495.90909	914.309484	4495.9091	9906.12767
C'Steads (I)	4597.236	229861.8	5224.13182	1062.40433	5224.1318	11510.668
C'Steads (II)	4147.794	207389.7	4713.40227	958.539933	4713.4023	10385.3445
Birdoswald	3594.422	179721.1	4084.5704	830.657689	4084.5704	8999.79848
						11066.2433

Name	Prob Total	Buiding Tea	Completion Time
Stanwix	36609.378	768	47.6684614
Bowness	28487.454	1056	26.9767558
C'Steads (I)	28089.292	480	58.5193583
C'Steads (II)	25990.901	480	54.14771
Birdoswald	29180.137	480	60.7919518
Avrg:	29671.432		49.6208475

Inchtuthil Ratio Total

Name	Prob Total	Buiding Tea	Completion Time
Stanwix	144801.87	768	188.544103
Bowness	119535.95	1056	113.196926
C'Steads (I)	109324.55	480	227.759478
C'Steads (II)	102458.13	480	213.454431
Birdoswald	128063.8	480	266.799573
Avrg:	120836.86		201.950902

§ A2.55 | Turf Fort Stone Rebuild: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name	Stone Vol	Turf Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Turf Cost	Stone	Cost in £'s	Construc. Units
Stanwix	6296.3616	5802.836	36609.3784	4393125.41	439312.54	366093.784	68882.1956	232113.441	3148180.79	8647708.153	864770.815
Bowness	5278.9023	3956.4	28487.4541	3418494.49	341849.45	284874.541	57751.1908	158256	2639451.13	6900676.804	690067.68
C'Steads (I)	4695.9506	4597.236	28089.292	3370715.04	337071.5	280892.92	51373.6994	183889.44	2347975.29	6571917.892	657191.789
C'Steads (II)	4412.5696	4147.794	25990.9008	3118908.1	311890.81	259909.008	48273.5111	165911.76	2206284.79	6111177.974	611117.797
Birdoswald	5717.0284	3594.422	29180.1369	3501616.43	350161.64	291801.369	62544.2911	143776.878	2858514.22	7208414.825	720841.482
Avrg:	5280.1625	4419.7376	29671.4324	3560571.89	356057.19	296714.324	57764.9776	176789.504	2640081.24	7087979.129	708797.913
Total:	21988.243	17950.894	122366.261	14683951.4	1468395.1	1223662.61	240551.377	718035.759	10994121.4	29328717.67	2932871.77

With Inchtuthil Ratio

Name	Stone Vol	Turf Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Turf Cost	Stone	Cost in £'s	Construc. Units
Stanwix	37148.533	5802.836	144801.871	17376224.6	1737622.5	1448018.71	406404.954	232113.441	18574266.6	39774650.78	3977465.08
Bowness	31145.523	3956.4	119535.953	14344314.4	1434431.4	1195359.53	340732.026	158256	15572761.7	33045855.11	3304585.51
C'Steads (I)	27706.108	4597.236	109324.55	13118945.9	1311894.6	1093245.5	303104.827	183889.44	13853054.2	29864134.54	2986413.45
C'Steads (II)	26034.16	4147.794	102458.127	12294975.2	1229497.5	1024581.27	284813.716	165911.76	13017080.2	28016859.73	2801685.97
Birdoswald	33730.468	3594.422	128063.795	15367655.4	1536765.5	1280637.95	369011.318	143776.878	16865233.9	35563080.98	3556308.1
Avrg:	31152.959	4419.7376	120836.859	14500423.1	1450042.3	1208368.59	340813.368	176789.504	15576479.3	33252916.23	3325291.62
Total:	155764.79	22098.688	604184.296	72502115.6	7250211.6	6041842.96	1704066.84	883947.519	77882396.7	166264581.1	16626458.1

Appendix 3 | The Cumberland Coast

§ A3.1 | Introduction

This is the data appendix for Chapter 7, the Cumberland coast. This will deal first with the linear ditches of the Cardurnock peninsula, before looking at the structures. These are the towers, milefortlets and forts that run from the Solway down the north-west of England. The sources used for this quantitative survey are shown on Table A3.1.

Table A3.1		
Site	Sources Used	Notes
Biglands Ditch (coast side)	Jones, 1976.	Presumed start at Bowness; base width assumed as rear;
Biglands Ditch (land side)	Jones, 1976.	Presumed start at Bowness; scaled from diagram.
CT2b Ditch (coast side)	Jones, 1976.	
CT2b Ditch (land side)	Jones, 1976.	Scaled from diagram.
CT4a Ditch (coast side)	Jones, 1976.	Presumed stop at MF5
CT4a Ditch (land side)	Jones, 1976.	Presumed stop at MF5; width scaled from diagram.
CT3a	Collingwood, 1929.	Door unknown.
CT3b	Collingwood, 1929.	Door unknown.
CT12a	Bellhouse, 1969.	Door unknown.

Table A3.1		
CT13a	Bellhouse, 1954.	Door unknown.
CT13b	Robinson, 1881.	
CT15a	Bellhouse, 1954.	Door unknown.
CT16a	Richmond, 1956.	Door unknown. South extent conjectural.
CT16b	Bellhouse, 1954.	Door unknown. East wall width as West.
CT20b	Bellhouse, 1963.	Door unknown.
CT21b	Bellhouse, 1966.	Door unknown.
CT25a	Bellhouse, 1984.	Door unknown.
MF1	Potter, 1977.	
MF5	Simpson & Hodgson, 1947.	
MF20	Bellhouse, 1970; *id*. 1981b.	
MF21	Turnbull, 1998.	
MF22	Bellhouse, 1970.	
Beckfoot	Robinson, 1881; Collingwood, 1936	Foundation depth assumed 0.2m.
Maryport	Wilson, 1997.	Foundation depth assumed 0.2m. Average portal size used.
Burrow Walls	Bellhouse, 1955.	Foundation depth assumed 0.2m. Average rampart backing size used.
Moresby	Birley, 1961.	Foundation depth assumed 0.2m. Average rampart backing and average portal size used.
Ravenglass	Potter, 1979; Blood, 1999.	Hadrianic Phase 0 fortlet examined.

Table A3.1: Sources used in Cumberland coast survey.

§ A3.2 | Coastal Ditches: Volume and Labour

Volumes

Zone	Zone Length	Ditch Width	Ditch Depth	Ditch Basewidth	Vol	
C. Biglands F	3500	1.5	0.8	0.35	2590	Zone lengths scaled from Jones, 1976,
C. Biglands R	3500	2	0.5	0.2	1925	Basewidth assumed as Rear
C. T2b F	2250	1.1	0.4	0.35	652.5	Scaled from diagram (Jones, 1976, 238,
C. T2b R	2250	1.1	0.4	0.45	697.5	Scaled from diagram (Jones, 1976, 240,
C. T4a F	1500	2.1	0.65	0.4	1218.75	
C. T4a R	1500	1.1	0.85	0.35	924.375	Width scaled from diagram (Jones, 197
Avrg:		1.48333333	0.6	0.35	1334.6875	
Total:					9342.8125	

Biglands zone from Bowness to where Ditch at T2b begins.
T2b zone runs to start of T4a zone.
T4b zone runs to MF5 (Cardunock)

Workrate	Earth Excav.	Mid point of Primitive tools rate (3.00cuft/0.91cum hour) and modern tools rate
	8	(3.58cuft/1.09cum hour) = 3.29cuft/1cum hour = 26.32cuft/8cum per day.
	Source: Jewell, P.A. (ed.), *The Experimental Earthwork on Overton Down*, London, 1963. Chp. 5.	

Zone	Vol	Digging	Total Person Days
C. Biglands F	2590	323.75	323.75
C. Biglands R	1925	240.625	240.625
C. T2b F	652.5	81.5625	81.5625
C. T2b R	697.5	87.1875	87.1875
C. T4a F	1218.75	152.34375	152.34375
C. T4a R	924.375	115.546875	115.546875
Avrg:	1334.6875	166.835938	166.835938
Total:	8008.125	1001.01563	1001.01563

§ A3.3 | Coastal Ditches: Quantitative Survey

Quantitative Survey

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Ditch Zone	Turf Vol	Prob Total	Labour	Supervision	Equipment	Turf	Total Cost
C. Biglands F	2590	323.75	38850	3885	3237.5	103600	149572.5
C. Biglands R	1925	240.625	28875	2887.5	2406.25	77000	111168.75
C. T2b F	652.5	81.5625	9787.5	978.75	815.625	26100	37681.875
C. T2b R	697.5	87.1875	10462.5	1046.25	871.875	27900	40280.625
C. T4a F	1218.75	152.34375	18281.25	1828.125	1523.4375	48750	70382.8125
C. T4a R	924.375	115.546875	13865.625	1386.5625	1155.46875	36975	53382.6563
Avrg:	1334.6875	166.835938	20020.3125	2002.03125	1668.35938	53387.5	77078.2031
Total:	8008.125	1001.01563	120121.875	12012.1875	10010.1563	320325	462469.219

§ A3.4 | Coastal Towers: Dimensions and Volumes

STONE

Turret Num	Wall	Length	Width	Found. Width	Found. Depth	Portal	Volume	Notes
3a	North	3.964	0.9144	0	0	0	26.294639	
	South	3.9624	0.9144	0	0	0	26.2840257	
	East	5.7912	0.9144	0	0	0	38.4151144	
	West	5.7912	0.9144	0	0	0	38.4151144	
3b	North	3.81	0.9144	1.2192	0.9906	0	29.8745892	
	South	3.81	0.9144	1.2192	0.9906	0	29.8745892	
	East	5.6388	0.9144	1.2192	0.9906	0	44.214392	
	West	5.6388	0.9144	1.2192	0.9906	0	44.214392	
12a	North	3.81	0.9144	1.014984	0.9144	0	28.8091678	
	South	3.81	0.9144	1.014984	0.9144	0	28.8091678	
	East	5.6388	0.9144	1.014984	0.9144	0	42.6375684	
	West	5.6388	0.9144	1.014984	0.9144	0	42.6375684	
13a	North	3.81	1.2192	0	0	0	30.3827688	
	South	3.81	1.2192	0	0	0	30.3827688	
	East	6.2484	1.2192	0	0	0	49.8277408	
	West	6.2484	1.2192	0	0	0	49.8277408	
13b	North	3.81	1.2192	0	0	0	30.3827688	
	South	3.81	1.2192	0	0	1.2192	27.7517547	
	East	6.2484	1.2192	0	0	0	49.8277408	
	West	6.2484	1.2192	0	0	0	49.8277408	
15a	North	4.2164	0.9144	1.2192	0	0.9144	26.4889537	
	South	4.2164	0.9144	1.2192	0	0	27.9688991	
	East	6.0452	0.9144	1.2192	0	0	40.0999879	
	West	6.0452	0.9144	1.2192	0	0	40.0999879	
16a	North	3.9624	0.9144	1.2192	1.0668	0	31.4376917	
	South	3.9624	0.9144	1.2192	1.0668	0	31.4376917	
	East	5.7912	0.9144	1.2192	1.0668	0	45.9473956	
	West	5.7912	0.9144	1.2192	1.0668	0	45.9473956	
16b	North	3.81	0.9144	1.2192	0	0	25.2731016	
	South	3.81	0.9144	1.2192	0	0	25.2731016	
	East	5.6388	0.9144	1.2192	0	0	37.4041904	
	West	5.6388	0.9144	1.2192	0	0	37.4041904	
20b	North	4.8768	0.9144	1.4859	0.3048	0	34.5582841	
	South	4.8768	0.9144	1.4859	0.3048	0	34.5582841	
	East	6.4008	0.9144	1.4859	0.3048	0	45.3577479	
	West	6.4008	0.9144	1.4859	0.3048	0	45.3577479	
21b	North	4.4196	0.9144	1.2192	0	0	29.3167979	
	South	4.4196	0.9144	1.2192	0	0	29.3167979	
	East	6.4008	0.9144	1.2192	0	0	42.4588107	
	West	6.4008	0.9144	1.2192	0	0	42.4588107	
25a	North	4.1402	0.9144	0	0	0	27.4634371	
	South	4.1402	0.9144	0	0	0	27.4634371	
	East	6.01472	0.9652	0	0	0	41.2422133	
	West	6.01472	0.9144	0	0	0	39.8978031	

§ A3.5 | Coastal Towers: Labour

Turret		Haulage		Building		Mortar			
Number	Type1 Tap. V	Low	High	Low	High	Low	High	Shaping	Scaffold
3a	129.408894	172.545191	51.7635574	11.4397462	22.8794924	288.84065	577.681301	90.2627033	38.4843442
3b	148.177962	197.570616	59.2711849	13.0989319	26.1978637	330.733212	661.466424	103.354129	44.0659953
12a	142.893472	190.52463	57.157389	12.631783	25.2635659	318.93823	637.876461	99.668197	42.494464
13a	160.421019	213.894692	64.1684077	14.1812181	28.3624362	358.059715	716.11943	111.893661	47.7069044
13b	157.790005	210.386674	63.1160021	13.9486365	27.8972729	352.187292	704.374583	110.058529	46.9244787
15a	134.657829	179.543771	53.8631314	11.903752	23.8075041	300.556273	601.112547	93.9238354	40.0453019
16a	154.770175	206.360233	61.9080699	13.6816834	27.3633669	345.44703	690.89406	107.952197	46.0264245
16b	125.354584	167.139445	50.1418336	11.0813452	22.1626904	279.791431	559.582863	87.4348223	37.2786508
20b	159.832064	213.109419	63.9328256	14.1291544	28.2583089	356.745167	713.490333	111.482865	47.5317576
21b	143.551217	191.401623	57.4204868	12.6899276	25.3798552	320.406317	640.812633	100.126974	42.6900678
25a	136.06689	181.422521	54.4267562	12.0283131	24.0566262	303.7013	607.402599	94.9066561	40.4643367
Avrg:	144.811283	193.08171	57.9245131	12.8013174	25.6026348	323.218783	646.437567	101.00587	43.0647933
Total:	1592.92411	2123.89882	637.169645	140.814491	281.628983	3555.40662	7110.81323	1111.06457	473.712726

Building Times

Turret	Prob. Total	Build Team	Est Comp. Time
3a	480.791001	8	60.0988752
3b	550.523453	8	68.8154316
12a	530.890063	8	66.3612579
13a	596.009906	8	74.5012383
13b	586.234937	8	73.2793672
15a	500.292294	8	62.5365368
16a	575.015405	8	71.8769256
16b	465.728083	8	58.2160104
20b	593.821769	8	74.2277211
21b	533.333773	8	66.6667216
25a	505.527362	8	63.1909202
Avrg:	538.015277		67.2519096
Total:	5918.16805		739.771006

§ A3.6 | Coastal Towers: Quantitative Survey

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Turret	Stone Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Cost in £'s	Con. Units
3a	129.408894	480.791001	57694.9202	5769.49202	4807.91001	9615.82003	64704.4468	142592.589	14259.2589
3b	148.177962	550.523453	66062.8143	6606.28143	5505.23453	11010.4691	74088.9811	163273.78	16327.378
12a	142.893472	530.890063	63706.8076	6370.68076	5308.90063	10617.8013	71446.7362	157450.926	15745.0926
13a	160.421019	596.009906	71521.1887	7152.11887	5960.09906	11920.1981	80210.5096	176764.114	17676.4114
13b	157.790005	586.234937	70348.1925	7034.81925	5862.34937	11724.6987	78895.0026	173865.062	17386.5062
15a	134.657829	500.292294	60035.0753	6003.50753	5002.92294	10005.8459	67328.9143	148376.266	14837.6266
16a	154.770175	575.015405	69001.8486	6900.18486	5750.15405	11500.3081	77385.0874	170537.583	17053.7583
16b	125.354584	465.728083	55887.37	5588.737	4657.28083	9314.56166	62677.292	138125.241	13812.5241
20b	159.832064	593.821769	71258.6122	7125.86122	5938.21769	11876.4354	79916.0319	176115.158	17611.5158
21b	143.551217	533.333773	64000.0527	6400.00527	5333.33773	10666.6755	71775.6085	158175.68	15817.568
25a	136.06689	505.527362	60663.2834	6066.32834	5055.27362	10110.5472	68033.4452	149928.878	14992.8878
Avrg:	144.811283	538.015277	64561.8332	6456.18332	5380.15277	10760.3055	72405.6414	159564.116	15956.4116
Total:	1592.92411	5918.16805	710180.166	71018.0166	59181.6805	118363.361	796462.056	1755205.28	175520.528

§ A3.7 | Milefortlets: Dimensions and Volumes

TURF

Fort Num	Wall	Length	Width	Wall Vol.1	Wall Vol.2	Portal	Notes
1	North	20	6.5	270.165	309.225	4.5	
	South	20	6.5	348.6	399	0	
	East	28	6.5	488.04	558.6	0	
	West	28	6.5	488.04	558.6	0	
5	North	28.956	8.8392	623.109431	693.390215	1.0668	
	South	28.956	7.62	572.807592	645.776712	0	
	East	55.4736	6.4008	955.348588	1095.14206	0	
	West	55.4736	7.62	1097.37876	1237.17223	0	
20	North	14.6304	6.4008	251.960067	288.828675	0	
	South	14.6304	6.4008	251.960067	288.828675	0	
	East	31.0896	6.4008	503.920134	577.65735	1.8288	
	West	31.0896	6.4008	535.415143	613.760935	0	
21	North	18	6.5	313.74	359.1	0	
	South	18	6.5	313.74	359.1	0	
	East	27	6.5	418.32	478.8	3	
	West	27	6.5	418.32	478.8	3	
22	North	20.7264	9.4488	489.608969	541.839497	0	
	South	20.7264	9.4488	489.608969	541.839497	0	
	East	36.576	6.4008	629.900168	722.071688	0	
	West	36.576	6.4008	598.405159	685.968103	1.8288	
Avrg:		28.0452	6.98912	502.919402	571.675032	2.3061	

Volume: Turf

Fort Num	Vol 1	Vol 2	Num Turf 1	Num Turf 2
1	1594.845	1825.425	53161.5	60847.5
5	3248.64437	3671.48121	108288.146	122382.707
20	1543.25541	1769.07563	51441.847	58969.1878
21	1464.12	1675.8	48804	55860
22	2207.52327	2491.71879	73584.1089	83057.2929
Avrg:	2011.67761	2286.70013	67055.9203	76223.3376
Total	10058.388	11433.5006	335279.601	381116.688

Volume: Timber

Name	Substructure	Parapet	Access Steps	G Ways	Rampart Wal	Barrack	Notes
1 - 1	0.8931132	6.24	26.64	32.9	6.72	120	
1 - 2	1.022238	6.24	26.64	32.9	11.52	120	
5 - 1	1.81924084	10.975848	26.64	21.2	11.820144	120	
5 - 2	2.05602948	10.975848	26.64	21.2	20.263104	120	
20 - 1	0.86422303	5.9436	26.64	21.2	6.4008	120	
20 - 2	0.99068236	5.9436	26.64	21.2	10.9728	120	
21 - 1	0.8199072	5.85	26.64	42.4	6.3	120	
21 - 2	0.938448	5.85	26.64	42.4	10.8	120	
22 - 1	1.23621303	7.449312	26.64	21.2	8.022336	120	
22 - 2	1.39536252	7.449312	26.64	21.2	13.752576	120	
Avrg 1	1.12653946	7.291752	26.64	27.78	7.852656	120	
Avrg 2	1.28055207	7.291752	26.64	27.78	13.461696	120	

§ A3.8 | Milefortlets: Labour

Workrate

Fort. Num	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways	Barrack
1 - 1	1208.21591	245.708541	1208.21591	122.854271	31.6710226	680	21.504	89.817	1170.92
1 - 2	1382.89773	281.232668	1382.89773	140.616334	32.2443367	680	36.864	89.817	1170.92
5 - 1	2461.09422	500.499841	2461.09422	250.24992	56.8101945	680	37.8244608	61.48	1170.92
5 - 2	2781.42516	565.643867	2781.42516	282.821934	57.861536	680	64.8419328	61.48	1170.92
20 - 1	1169.13289	237.760432	1169.13289	118.880216	30.2267343	680	20.48256	61.48	1170.92
20 - 2	1340.20881	272.551247	1340.20881	136.275624	30.7882137	680	35.11296	61.48	1170.92
21 - 1	1109.18182	225.568497	1109.18182	112.784248	29.614388	680	20.16	122.96	1170.92
21 - 2	1269.54545	258.18081	1269.54545	129.090405	30.1407091	680	34.56	122.96	1170.92
22 - 1	1672.36611	340.100337	1672.36611	170.050168	38.5637311	680	25.6714752	61.48	1170.92
22 - 2	1887.66575	383.884696	1887.66575	191.942348	39.2703549	680	44.0082432	61.48	1170.92
Avrg 1	1523.99819	309.92753	1523.99819	154.963765	37.3772141	680	25.1284992	79.4434	1170.92
Avrg 2	1732.34858	352.298658	1732.34858	176.149329	38.0610301	680	43.0774272	79.4434	1170.92
Total 1	7619.99094	1549.63765	7619.99094	774.818824	186.88607	3400	125.642496	397.217	5854.6
Total 2	8661.7429	1761.49329	8661.7429	880.746644	190.30515	3400	215.387136	397.217	5854.6

Completion Time

Fort. Num	Type	Total Person	Build Team	Comp. Time
1	I	4778.90665	16	298.681666
	ii	5197.48979	16	324.843112
5	I	7679.97285	16	479.998303
	ii	8446.41959	16	527.901225
20	I	4658.01572	16	291.125982
	ii	5067.54567	16	316.721605
21	I	4580.37077	16	286.273173
	II	4964.94283	16	310.308927
22	I	5831.51793	16	364.469871
	ii	6346.83714	16	396.677321
Avrg 1		5505.75678		344.109799
Avrg 2		6004.64701		375.290438
Total 1		27528.7839		1720.549
Total 2		30023.235		1876.45219

§ A3.9 | Milefortlets: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Fort. Num	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
1 - 1	1594.845	193.393113	4778.90665	573468.798	57346.8798	47789.0665	63793.8	29008.967
1 - 2	1825.425	198.322238	5197.48979	623698.775	62369.8775	51974.8979	73017	29748.3357
5 - 1	3248.64437	192.455233	7679.97285	921596.742	92159.6742	76799.7285	129945.775	28868.2849
5 - 2	3671.48121	201.134981	8446.41959	1013570.35	101357.035	84464.1959	146859.249	30170.2472
20 - 1	1543.25541	181.048623	4658.01572	558961.886	55896.1886	46580.1572	61730.2164	27157.2935
20 - 2	1769.07563	185.747082	5067.54567	608105.481	60810.5481	50675.4567	70763.0254	27862.0624
21 - 1	1464.12	202.009907	4580.37077	549644.492	54964.4492	45803.7077	58564.8	30301.4861
21 - 2	1675.8	206.628448	4964.94283	595793.14	59579.314	49649.4283	67032	30994.2672
22 - 1	2207.52327	184.547861	5831.51793	699782.152	69978.2152	58315.1793	88300.9306	27682.1792
22 - 2	2491.71879	190.437251	6346.83714	761620.456	76162.0456	63468.3714	99668.7514	28565.5876
Avrg 1	2011.67761	190.690947	5505.75678	660690.814	66069.0814	55057.5678	80467.1043	28603.6421
Avrg 2	2286.70013	196.454	6004.64701	720557.641	72055.7641	60046.4701	91468.0051	29468.1
Total 1	10058.388	953.454737	27528.7839	3303454.07	330345.407	275287.839	402335.522	143018.211
Total 2	11433.5006	982.27	30023.235	3602788.2	360278.82	300232.35	457340.025	147340.5

Fort. Num	Total Cost	Construc Units
1 - 1	771407.512	77140.7512
1 - 2	840808.886	84080.8886
5 - 1	1249370.2	124937.02
5 - 2	1376421.08	137642.108
20 - 1	750325.742	75032.5742
20 - 2	818216.573	81821.6573
21 - 1	739278.935	73927.8935
21 - 2	633945.933	63394.5933
22 - 1	944058.656	94405.8656
22 - 2	1029485.21	102948.521
Avrg 1	890888.21	89088.821
Avrg 2	939775.537	93977.5537
Total 1	4454441.05	445444.105
Total 2	4698877.68	469887.768

§ A3.10 | Stone Coastal Forts: Dimensions

Dimensions

Name	Wall	Length	Width	Found. Width	Found. Depth	Wall Vol.	Portal	Portal Vol	Rampart Bac	Rampart Vol	Notes
Beckfoot	North	123.444	1.8288	0	0.2	901.345294	6.096	4.25449472	4.572	1126.681618	
	South	123.444	1.8288	0	0.2	901.345294	6.096	4.25449472	4.572	1126.681618	
	East	81.3816	1.8288	0	0.2	578.265682	6.096	4.25449472	4.572	722.8321027	
	West	86.2584	1.8288	0	0.2	615.724188	6.096	4.25449472	4.572	769.6552349	
Maryport	North	160	2	0	0.2	1301.11464	5.1054	3.89669655	7.9248	2577.768325	
	South	160	2	0	0.2	1301.11464	5.1054	3.89669655	7.9248	2577.768325	
	East	169	2	0	0.2	1376.71464	5.1054	3.89669655	7.9248	2727.547045	
	West	169	2	0	0.2	1376.71464	5.1054	3.89669655	7.9248	2727.547045	
Burrow Walls	North	84.4296	2.286	2.7432	0.2	815.18237	4.1148	3.58972992	6.2484	1053.861892	
	South	84.4296	2.286	2.7432	0.2	815.18237	4.1148	3.58972992	6.2484	1053.861892	
	East	137.16	2.286	2.7432	0.2	1350.38749	4.1148	3.58972992	6.2484	1745.771218	
	West	137.16	2.286	2.7432	0.2	1350.38749	4.1148	3.58972992	6.2484	1745.771218	
Moresby	North	134.112	1.4478	1.8034	0.2	830.988274	5.1054	2.82081863	6.2484	1692.778163	
	South	134.112	1.4478	1.8034	0.2	830.988274	5.1054	2.82081863	6.2484	1692.778163	
	East	112.014	1.4478	1.8034	0.2	688.645332	5.1054	2.82081863	6.2484	1402.816162	
	West	112.014	1.4478	1.8034	0.2	688.645332	5.1054	2.82081863	6.2484	1402.816162	
Avrg:						982.671622	5.1054	3.64043495	6.2484	1634.183511	

Pivot-Floor Joist — Source: AA5,20, 46-9.

Name	Length	Height	Width	Total Vol.
Beckfoot	24.384	0.61	1.8288	27.2020101
Maryport	20.4216	0.61	2	24.914352
Burrow Walls	16.4592	0.61	2.286	22.951696
Moresby	20.4216	0.61	1.4478	18.0354994

§ A3.11 | Stone Coastal Forts: Turret Dimensions and Volumes

Fort	Turret	Wall	Length	Width	Portal Size	Volume	Scaffold	Notes
Beckfoot	NE Angle	North	2.4384	1.8288	0	25.985346		Non fort wall widths taken from guard chambers
		South	2.4384	0.762	0	14.5396915		
		East	4.7244	0.762	0	28.1706523		
		West	4.7244	0.762	0	28.1706523		
	NW Angle	North	2.4384	1.8288	0	25.985346		Non fort wall widths taken from guard chambers
		South	2.4384	0.762	0	14.5396915		
		East	4.7244	0.762	0	28.1706523		
		West	4.7244	0.762	0	28.1706523		
	SW Angle	North	2.4384	0.762	0	14.5396915		Non fort wall widths taken from guard chambers
		South	2.4384	1.8288	0	25.985346		
		East	4.7244	0.762	0	28.1706523		
		West	4.7244	0.762	0	28.1706523		
	SE Angle	North	2.4384	0.762	0	14.5396915		Non fort wall widths taken from guard chambers
		South	2.4384	1.8288	0	25.985346		
		East	4.7244	0.762	0	28.1706523		
		West	4.7244	0.762	0	28.1706523		
	N, chamber	North	2.7432	1.8288	0	29.2335143		
		South	2.7432	0.762	0	16.357153		
		East	5.334	0.762	0	31.8055752		
		West	5.334	0.762	0	31.8055752		
	S-W Chambe	North	2.7432	0.762	0	16.357153		
		South	2.7432	1.8288	0	29.2335143		
		East	5.334	0.762	0	31.8055752		
		West	5.334	0.762	0	31.8055752		
	S-E Chamber	North	2.7432	0.762	0	16.357153		
		South	2.7432	1.8288	0	29.2335143		
		East	5.334	0.762	0	31.8055752		
		West	5.334	0.762	0	31.8055752		
	E-N Chamber	North	2.7432	0.762	0	16.357153		
		South	2.7432	0.762	0	16.357153		
		East	4.2672	1.8288	0	45.4743556		
		West	4.2672	0.762	0	25.4444602		
	E-S Chamber	North	2.7432	0.762	0	16.357153		
		South	2.7432	0.762	0	16.357153		
		East	4.2672	1.8288	0	45.4743556		
		West	4.2672	0.762	0	25.4444602		
Avrg:						25.620474		

§ A3.12 | Stone Coastal Forts: Total Volumes

Total Fort Volume

Name	Basic Vol	Turret Vol.	Gateway Vol.	Total StoneV	Turf Volume
Beckfoot	2996.68046	1024.81896	44.2199989	4065.71941	3745.85057
Maryport	5355.65856	0	41.5745327	5397.23309	10610.6307
Burrow Wall	4331.13972	0	39.2540786	4370.3938	5599.26622
Moresby	3039.26721	0	33.9800838	3073.2473	6191.18865

§ A3.13 | Stone Coastal Forts: Labour

Stone Fort		Haulage		Building		Mortar			
Name	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold
Beckfoot	4065.71941	5420.95921	1626.28776	368.354178	736.708357	8895.79407	17791.5881	2779.93565	290.408529
Maryport	5397.23309	7196.31079	2158.89324	488.989318	977.978636	11809.146	23618.292	3690.35813	385.516649
Burrow Wall	4370.3938	5827.19174	1748.15752	395.957679	791.915357	9562.42164	19124.8433	2988.25676	312.170986
Moresby	3073.2473	4097.66306	1229.29892	278.436205	556.87241	6724.26508	13448.5302	2101.33284	219.517664

Name	Vol	Turf Num	Turf Cutting	Haulage	Laying	Total Person Days
Beckfoot	3745.85057	187292.529	4256.64838	865.652286	865.652286	5987.95295
Maryport	10610.6307	530531.537	12057.5349	2452.07773	2452.07773	16961.6904
Burrow Wall	5599.26622	279963.311	6362.80252	1293.96982	1293.96982	8950.74217
Moresby	6191.18865	309559.432	7035.44165	1430.76092	1430.76092	9896.96349

Name	Prob Total	Buiding Team	Completion Time
Beckfoot	19948.7331	500	39.8974663
Maryport	35494.5937	1000	35.4945937
Burrow Wall	23957.7068	500	47.9154135
Moresby	20449.8142	500	40.8996284
Avrg:	25297.7137		38.7638961

Inchtuthil Ratio Total

Name	Prob Total	Buiding Team	Completion Time
Beckfoot	88356.556	500	176.713112
Maryport	126305.82	1000	126.30582
Burrow Wall	97491.8333	500	194.983667
Moresby	72158.7827	500	144.317565
Avrg:	95607.0529		149.112166

§ A3.14 | Stone Coastal Forts: Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name	Stone Vol	Turf Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Turf Cost	Stone	Cost in £'s	Construc. Units
Beckfoot	4065.71941	3745.85057	19948.7331	2393847.98	239384.798	199487.331	398974.663	149834.023	2032859.7	5414388.495	541438.849
Maryport	5397.23309	10610.6307	35494.5937	4259351.25	425935.125	354945.937	709891.874	424425.23	2698616.55	8873165.959	887316.596
Burrow Wall	4370.3938	5599.26622	23957.7068	2874924.81	287492.481	239577.068	479154.135	223970.649	2185196.9	6290316.046	629031.605
Moresby	3073.2473	6191.18865	20449.8142	2453977.7	245397.77	204498.142	408996.284	247647.546	1536623.65	5097141.093	509714.109
Avrg:	4178.73327	6849.22332	25297.7137	3035725.64	303572.564	252977.137	505954.274	273968.933	2089366.63	6461565.182	646156.518
Total:	16906.5936	26146.9362	99850.8478	11982101.7	1198210.17	998508.478	1997016.96	1045877.45	8453296.8	25675011.59	2567501.16

With Inchtuthil Ratio

Name	Stone Vol	Turf Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Turf Cost	Stone	Cost in £'s	Construc. Units
Beckfoot	23987.7445	3745.85057	88356.556	10602786.7	1060278.67	883565.56	262425.925	149834.023	11993872.3	24952763.16	2495276.32
Maryport	31843.6752	10610.6307	126305.82	15156698.4	1515669.84	1263058.2	348369.807	424425.23	15921837.6	34630059.11	3463005.91
Burrow Wall	25785.3234	5599.26622	97491.8333	11699020	1169902	974918.333	282091.438	223970.649	12892661.7	27242564.13	2724256.41
Moresby	18132.159	6191.18865	72158.7827	8659053.92	865905.392	721587.827	198365.82	247647.546	9066079.52	19758640.03	1975864
Avrg:	24937.2256	6536.73405	96078.248	11529389.8	1152938.98	960782.48	272813.248	261469.362	12468612.8	26646006.61	2664600.66
Total:	99748.9022	26146.9362	384312.992	46117559	4611755.9	3843129.92	1091252.99	1045877.45	49874451.1	106584026.4	10658402.6

§ A3.15 | Ravenglass: Volumes, Labour and Quantitative Survey

Name	Wall	Length	Width	Wall Vol 1	Wall Vol 2	Portal	Notes
Ravenglass	North	24	6.5	329.332878	376.94727	5.1054	
Phase0	South	24	6.5	329.332878	376.94727	5.1054	
	East	34	6.5	503.632878	576.44727	5.1054	
	West	34	6.5	503.632878	576.44727	5.1054	
TOTAL				1665.93151	1906.78908		

Volume: Timber

Name		Substructure	Parapet	Access Steps	G Ways	Rampart Wa	Barrack	Total	Notes
Ravenglass	Type 1	0.93292165	7.54	26.64	131.6	8.12	120	294.832922	
Phase0	Type 2	1.06780188	7.54	26.64	131.6	13.92	120	300.767802	

Workrate

Name		Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways	Barrack	Total	Build Team	Comp. Time
Ravenglass	Type 1	37.8620798	7.69981287	37.8620798	128.330214	37.6197721	680	43.036	359.268	1170.92	2502.59796	16	156.412372
Phase0	Type 2	43.3361155	8.81303882	43.3361155	146.88398	38.2186404	680	73.776	359.268	1170.92	2564.55189	16	160.284493

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Name		Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber	TOTAL COST
Ravenglass	Type 1	1665.93151	294.832922	2502.59796	300311.755	30031.1755	25025.9796	66637.2605	44224.9382	466231.109
Phase0	Type 2	1906.78908	300.767802	2564.55189	307746.227	30774.6227	25645.5189	76271.5632	45115.1703	485553.102

Appendix 4 | The Outpost Forts

§ A4.1 | Introduction

This is the data appendix for Chapter 8, the Outpost forts. Whilst §8.6 concludes that the Outpost forts were not connected to the Wall, chronologically or functionally, part of this reasoning is related to their differing quantitative results from Hadrian's Wall. Consequently, this data appendix is important in demonstrating this conclusion. The excavations used to generate the quantitative data can be seen on Table A4.1. This includes all sites considered part of the Outpost fort network with enough surviving anatomy to make estimations. A list of excavations for sites can be found in Breeze, 2006, 504, covering those not included here.

Table A4.1	
Site	Sources Used
Bewcastle	Sainsbury & Welfare, 1990.
Blakehope	Dodds, 1940; Birley, 1961.
Birrens (Hadrianic fort)	Robertson, 1975.
Learchild	Wright, 1957.
Cappuck	Stevenson & Miller, 1912; Richmond, 1950.
Risingham	Richmond, 1936.
Newstead	Curle, 1911.
Robin Hood's Butt	Haverfield, 1901; Richmond, 1933.

Table A4.1: Sources used in quantification of Outpost forts.

§ A4.2 | Turf Dimensions and Volumes

LOCKED VARIABLES

Fort Wall Hgt	T Width 1+	T1 Height	T2 Height	T3 Height	T1 Height 1+	T2 Height 1+	T3 Height 1+	T Height G
4.2	0.45	10.2	11.7	13.2	5.8	7.3	8.8	4.4
Portal Height	Pivet-Floor H	Door Height	Turf TopW.1	Turf TopW.2	Pi			
3.55	0.61	1.77	1.8	3	3.14			

TURF

Name	Wall	Length	Width	Wall Vol.1	Wall Vol.2	Portal	Portal Vol	Notes
Bewcastle	North	121.92	6.5	2125.0656	2432.304	0		SW Width Used
	East	109.728	6.5	1912.55904	2189.0736	0		SW Width Used
	South East	91.44	6.5	1593.7992	1824.228	0		SW Width Used
	South West	109.728	6.5	1912.55904	2189.0736	0		
	West	121.92	6.5	2125.0656	2432.304	0		SW Width Used
	North West	83.82	6.096	1389.86971	1601.09611	0		SW Width Used
Blakehope	North	103.632	6.096	1566.76222	1804.87198	9.144		
	South	103.632	7.62	2050.04822	2311.20086	0		
	East	135.636	7.62	2683.15135	3024.95407	0		
	West	135.636	7.62	2592.70805	2922.98933	4.572		
Birrens, II	North	105.5411	6.7056	1885.1498	2151.11337	0		
	South	105.5411	6.7056	1885.1498	2151.11337	0		
	East	141.32992	6.7056	2524.40111	2880.55251	0		
	West	141.32992	6.7056	2524.40111	2880.55251	0		
Learchild	North	39.624	7.0104	733.116908	832.969388	0		Early fort wall width used.
	South	39.624	7.0104	733.116908	832.969388	0		Wall length as N
	East	90.2208	7.0104	1669.25081	1896.60722	0		
	West	90.2208	7.0104	1669.25081	1896.60722	0		Wall length as E
Cappuck	North	58.8264	7.1628	1107.22344	1255.46597	0		
	South	58.8264	7.1628	1107.22344	1255.46597	0		
	East	79.248	7.1628	1376.85817	1561.20121	6.096		
	West	79.248	7.1628	1491.59635	1691.30131	0		

§ A4.3 | Turf and Timber Volumes

34							
35	Volume Turf						
36	Name	Vol 1	Vol 2	Num Turf 1	Num Turf 2		
37	Bewcastle	11058.91819	12668.0793	368630.606	422269.31		
38	Blakehope	8892.669845	5459.15322	296422.328	181971.774		
39	Birrens, II	8819.10182	10063.3318	293970.061	335444.392		
40	Learchild	4804.735429	5459.15322	160157.848	181971.774		
41	Cappuck	5082.901395	5763.43445	169430.047	192114.482		
42	Avrg	7731.665336	7882.63039	257722.178	262754.346		
43	Total	38658.32668	39413.152	1288610.89	1313771.73		
44							
45	Volume, Timber Type 1						
46	Name	Substructure	Parapet	Access Steps	G Ways	Rampart Wal	Notes
47	Bewcastle	6.192994188	41.50614	89.91	197.4	44.69892	6Dbl gways; 27 access ways presumed
48	Blakehope	4.979895113	16.879824	59.94	131.6	18.178272	4Dbl gways; 18 access ways presumed
49	Birrens, II	4.938697019	32.0932326	59.94	131.6	34.5619428	4Dbl gways; 18 access ways presumed
50	Learchild	2.69065184	16.879824	59.94	131.6	18.178272	4Dbl gways; 18 access ways presumed
51	Cappuck	2.846424781	17.949672	59.94	131.6	19.330416	4Dbl gways; 18 access ways presumed
52	Avrg	4.329732588	25.0617385	65.934	144.76	26.9895646	
53	Total	21.64866294	125.308693	329.67	723.8	134.947823	
54							
55	Volume, Timber Type 2						
56	Name	Substructure	Parapet	Access Steps	G Ways	Rampart Wal	Notes
57	Bewcastle	7.094124415	41.50614	89.91	197.4	76.62672	6Dbl gways; 27 access ways presumed
58	Blakehope	3.057125804	16.879824	59.94	131.6	31.162752	4Dbl gways; 18 access ways presumed
59	Birrens, II	5.635465786	32.0932326	59.94	131.6	59.2490448	4Dbl gways; 18 access ways presumed
60	Learchild	3.057125804	16.879824	59.94	131.6	31.162752	4Dbl gways; 18 access ways presumed
61	Cappuck	3.227523293	17.949672	59.94	131.6	33.137856	4Dbl gways; 18 access ways presumed
62	Avrg	4.41427302	25.0617385	65.934	144.76	46.267825	
63	Total	22.0713651	125.308693	329.67	723.8	231.339125	
64							

§ A4.4 | Turf and Timber Labour Demand

Workrate, Type 1

Name	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways
Bewcastle	8377.968327	1703.78354	8377.96833	851.891769	211.784156	2295	143.036544	538.902
Blakehope	6736.871095	1370.04219	6736.87109	685.021095	97.0571529	1530	58.1704704	359.268
Birrens, II	6681.137743	1358.70799	6681.13774	679.353995	164.421768	1530	110.598217	359.268
Learchild	3639.951082	740.237787	3639.95108	370.118894	86.8929127	1530	58.1704704	359.268
Cappuck	3850.682875	783.093208	3850.68288	391.546604	92.3346697	1530	61.8573312	359.268
Avrg	5857.322224	1191.17294	5857.32222	595.586471	130.498132	1683	86.3666066	395.1948
Total	29286.61112	5955.86471	29286.6111	2977.93236	652.490659	8415	431.833033	1975.974

Workrate, Type 2

Name	Turf Cutting	Haulage	Laying	Core Haul.	Parapet	Access	Rampart	G/Ways
Bewcastle	9597.029782	1951.69768	9597.02978	975.848841	215.785174	2295	245.205504	538.902
Blakehope	4135.722137	841.06015	4135.72214	420.530075	88.5200571	1530	99.7208064	359.268
Birrens, II	7623.736183	1550.3993	7623.73618	775.199649	167.515421	1530	189.596943	359.268
Learchild	4135.722137	841.06015	4135.72214	420.530075	88.5200571	1530	99.7208064	359.268
Cappuck	4366.238221	887.938998	4366.23822	443.969499	94.0267471	1530	106.041139	359.268
Avrg	5971.689692	1214.43126	5971.68969	607.215628	130.873491	1683	148.05704	395.1948
Total	29858.44846	6072.15628	29858.4485	3036.07814	654.367456	8415	740.285199	1975.974

Name	Type	Total Person	Build Team	Comp. Time	IR: pers. Day	IR: Com. Time	
Bewcastle	I	22500.3347	1000	22.5003347	132751.975	132.751975	
	II	25416.4988	1000	25.4164988	149957.343	149.957343	
Blakehope	I	17573.3011	500	35.1466022	103682.476	207.364953	
	II	11610.5434	500	23.2210867	68502.2058	137.004412	
Birrens, II	I	17564.6255	500	35.1292509	103631.29	207.26258	Build Team of 500 presumed
	II	19819.4517	500	39.6389034	116934.765	233.86953	Build Team of 500 presumed
Learchild	I	10424.5902	500	20.8491805	61505.0823	123.010165	Build Team of 500 presumed
	II	11610.5434	500	23.2210867	68502.2058	137.004412	Build Team of 500 presumed
Cappuck	I	10919.4656	500	21.8389311	64424.8468	128.849694	Build Team of 500 presumed
	II	12153.7208	500	24.3074417	71706.9529	143.413906	Build Team of 500 presumed
Avrg Tp1		15796.4634		27.0928599	93199.1341	159.847873	
Avrg Tp2		16122.1516		27.1610034	95120.6944	160.24992	
Total Tp1		78982.317		135.464299	465995.67	799.239366	
Total Tp2		80610.758		135.805017	475603.472	801.249602	

§ A4.5 | Turf and Timber Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Fort	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
Bewcastle Tp	11058.91819	379.708054	22500.3347	2700040.16	270004.016	225003.347	442356.728	56956.2081
Bewcastle Tp	12668.07931	412.536984	25416.4988	3049979.85	304997.985	254164.988	506723.172	61880.5477
Blakehope T	8892.669845	231.577991	17573.3011	2108796.13	210879.613	175733.011	355706.794	34736.6987
Blakehope T	5459.153221	242.639702	11610.5434	1393265.2	139326.52	116105.434	218366.129	36395.9553
Birrens Tp1	8819.10182	263.133872	17564.6255	2107755.05	210775.505	175646.255	352764.073	39470.0809
Birrens Tp2	10063.33176	288.517743	19819.4517	2378334.2	237833.42	198194.517	402533.27	43277.6615
Learchild Tp1	4804.735429	229.288748	10424.5902	1250950.83	125095.083	104245.902	192189.417	34393.3122
Learchild Tp	5459.153221	242.639702	11610.5434	1393265.2	139326.52	116105.434	218366.129	36395.9553
Cappuck Tp1	5082.901395	231.666513	10919.4656	1310335.87	131033.587	109194.656	203316.056	34749.9769
Cappuck Tp2	5763.434451	245.855051	12153.7208	1458446.5	145844.65	121537.208	230537.378	36878.2577
Avrg Tp1	7731.665336	267.075036	15796.4634	1895575.61	189557.561	157964.634	309266.613	40061.2554
Avrg Tp2	7882.630393	286.437837	16122.1516	1934658.19	193465.819	161221.516	315305.216	42965.6755
Total Tp1	38658.32668	1335.37518	78982.317	9477878.04	947787.804	789823.17	1546333.07	200306.277
Total Tp2	39413.15197	1432.18918	80610.758	9673290.96	967329.096	806107.58	1576526.08	214828.377

Fort	Total Cost	Construc Units
Bewcastle Tp	3694360.458	369436.046
Bewcastle Tp	4177746.545	417774.654
Blakehope T	2885852.248	288585.225
Blakehope T	1903459.242	190345.924
Birrens Tp1	2886410.968	288641.097
Birrens Tp2	3260173.07	326017.307
Learchild Tp1	1706874.542	170687.454
Learchild Tp2	1903459.242	190345.924
Cappuck Tp1	1788630.143	178863.014
Cappuck Tp2	1993243.993	199324.399
Avrg Tp1	2592425.672	259242.567
Avrg Tp2	2647616.418	264761.642
Total Tp1	12962128.36	1296212.84
Total Tp2	13238082.09	1323808.21

§ A4.6 | Turf and Timber Quantitative Survey with Inchtuthil Ratio

42	**With Inchtuthil Ratio**								
43									
44	Fort	Turf Vol	Timber Vol	Prob Total	Labour	Supervision	Equipment	Turf	Timber
45	Bewcastle Tp	11058.91819	2240.27752	132751.975	15930236.9	1593023.69	1327519.75	442356.728	336041.628
46	Bewcastle Tp	12668.07931	2433.96821	149957.343	17994881.1	1799488.11	1499573.43	506723.172	365095.231
47	Blakehope T	8892.669845	1366.31015	103682.476	12441897.2	1244189.72	1036824.76	355706.794	204946.522
48	Blakehope T	5459.153221	1431.57424	68502.2058	8220264.7	822026.47	685022.058	218366.129	214736.136
49	Birrens Tp1	8819.10182	1552.48985	103631.29	12435754.8	1243575.48	1036312.9	352764.073	232873.477
50	Birrens Tp2	10063.33176	1702.25468	116934.765	14032171.8	1403217.18	1169347.65	402533.27	255338.203
51	Learchild Tp1	4804.735429	1352.80361	61505.0823	7380609.88	738060.988	615050.823	192189.417	202920.542
52	Learchild Tp	5459.153221	1431.57424	68502.2058	8220264.7	822026.47	685022.058	218366.129	214736.136
53	Cappuck Tp1	5082.901395	1366.83243	64424.8468	7730981.62	773098.162	644248.468	203316.056	205024.864
54	Cappuck Tp2	5763.434451	1450.5448	71706.9529	8604834.34	860483.434	717069.529	230537.378	217581.72
55	Avrg Tp1	7731.665336	1575.74271	93199.1341	11183896.1	1118389.61	931991.341	309266.613	236361.407
56	Avrg Tp2	7882.630393	1689.98324	95120.6944	11414483.3	1141448.33	951206.944	315305.216	253497.485
57	Total Tp1	38658.32668	7878.71355	465995.67	55919480.4	5591948.04	4659956.7	1546333.07	1181807.03
58	Total Tp2	39413.15197	8449.91618	475603.472	57072416.7	5707241.67	4756034.72	1576526.08	1267487.43
59									
60	Fort	Total Cost	Construc Units						
61	Bewcastle Tp	19629178.74	1962917.87						
62	Bewcastle Tp	22165761.07	2216576.11						
63	Blakehope T	15283564.97	1528356.5						
64	Blakehope T	10160415.49	1016041.55						
65	Birrens Tp1	15301280.76	1530128.08						
66	Birrens Tp2	17262608.09	1726260.81						
67	Learchild Tp1	9128831.653	912883.165						
68	Learchild Tp2	10160415.49	1016041.55						
69	Cappuck Tp1	9556669.169	955666.917						
70	Cappuck Tp2	10630506.41	1063050.64						
71	Avrg Tp1	13779905.06	1377990.51						
72	Avrg Tp2	14075941.31	1407594.13						
73	Total Tp1	68899525.29	6889952.53						
74	Total Tp2	70379706.55	7037970.65						

§ A4.7 | Stone Dimensions and Volumes

STONE

Name	Wall	Length	Width	Wall Vol.	Found. Wi	Found. Depth	Found. Vol	Portal	Portal Vol	Rampart Bac	Notes
Risingham	North	122.5296	1.7526	878.853468				3.1350857	5.3844783	7.62	portal presumed as west
	South	122.5296	1.7526	878.853468				3.1350857	5.3844783	7.62	portal presumed as west
	East	148.6662	1.7526	1071.24289				3.1350857	5.3844783	7.62	portal presumed as west
	West	148.6662	1.7526	1071.24289				3.1350857	5.3844783	7.62	portal scaled from diagramme; AA(4) XIII, fp. 186.
Newstead	North	219.456	2.3114	2100.8629	2.5908	0.2286	129.9743259	3.048	8.2581293	11.5824	
	South	219.456	2.3114	2100.8629	2.5908	0.2286	129.9743259	3.048	8.2581293	11.5824	
	East	251.5108	2.3114	2415.00601	2.5908	0.2286	148.9590017	2.7432	7.4323164	11.5824	
	West	251.5108	2.3114	2406.12912	2.5908	0.2286	148.9590017	3.6576	9.9097551	11.5824	
Robin Hood's B	North	5.4864	0.8382	34.5537861				0	0		
	South	5.1816	0.8382	32.6341313				0	0		
	East	7.7216	0.8382	48.6312545				0	0		
	West	7.7724	0.8382	48.951197				0	0		

Pivot-Floor Joist — Source: AA5,20, 46-9.

Name	Wall	Length	Width	Total Vol.
Risingham	North	3.1350857	1.7526	3.35167623
	South	3.1350857	1.7526	3.35167623
	East	3.1350857	1.7526	3.35167623
	West	3.1350857	1.7526	3.35167623
Newstead	North	3.048	2.3114	4.29753979
	South	3.048	2.3114	4.29753979
	East	2.7432	2.3114	3.86778581
	West	3.6576	2.3114	5.15704775

Rampart Backing

Fort	Wall	Rampart Back Vol.
Risingham	North	1960.71866
	South	1960.71866
	East	2378.95653
	West	2378.95653
Newstead	North	5337.83707
	South	5337.83707
	East	6117.50725
	West	6117.50725

Fort Turrets

Fort	Turret	Wall	Length	Width	Portal Size	Type 1 Tap	Type 2 Tap	Type 3 Tap	
Risingham	W G.Way, N	North	2.3368	0.8128	0	14.4561926	16.03353258	17.6108726	
		South	2.3368	0.9144	0	15.5008356	17.07817565	18.6555156	
		East	3.7084	0.8382	0.8648	22.0727705	24.57594048	27.0791105	Avrg portal
		West	3.7084	1.9304	0	41.1771836	43.68035358	46.1835236	
	W G.Way, S	North	2.1336	0.8382	0	13.4375835	14.87776349	16.3179435	
		South	2.1336	0.8382	0	13.4375835	14.87776349	16.3179435	
		East	3.7084	0.8382	0.8648	22.0727705	24.57594048	27.0791105	Avrg portal
		West	3.7084	1.9812	0	42.0060852	44.50925515	47.0124252	

Turret Scaffold Workrates

Fort	Turret	Vol	Scaffold
Risingham	W G.Way, N	93.2069823	27.7184163
	W G.Way, S	90.9540226	27.0484185
Avrg:		92.0805025	27.3834174

Total Fort Volume

Name	Reference	Basic Vol	Turret Vol.	Gateway Vol.	Total Ston	Total Turf Vol	
Risingham		3900.19272	1104.96603	34.9446183	5040.1	8679.35038	12 Towers presumed; 10 Avrg Used
Newstead		9580.72758	1104.96603	51.4782432	10737.2	22910.6886	12 Towers presumed; 12 Avrg Used

§ A4.8 | Stone Fort Labour Demand

Workrates

Stone		Haulage		Building		Mortar			
Name	Vol	Low	High	Low	High	Low	High	Shaping	Scaffold
Risingham	5040.10336	6720.13782	2016.04135	456.633365	913.267	11027.7462	22055.49232	3446.17068	609.68225
Newstead	10737.1718	14316.2291	4294.86874	972.78777	1945.58	23492.932	46985.86401	7341.54125	1016.6157

Turf Back	Vol	Turf Num	Turf Cutting	Haulage	Laying	Core Haulage	Total Person Days
Risingham	8679.35038	433967.519	9862.89816	2005.76594	9862.9	668.588647	22400.15091
Newstead	22910.6886	1145534.43	26034.8734	5294.57585	26034.9	1764.85862	59129.18136

Name	Prob Total	Buiding Team	Completion Time	
Risingham	39956.4247	500	79.9128494	
Newstead	96247.9268	500	192.495854	CHECK GARRISON SIZE, FIGURES HERE IMPLY MILLIARY UNIT

Inchtuthil Ratio Total

Name	Prob Total	Buiding Team	Completion Time
Risingham	103582.015	500	207.164031
Newstead	219000.598	500	438.001197

§ A4.9 | Stone Fort Quantitative Survey

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Fort	Stone Vol	Turf Vol	Prob. Total	Labour	Supervisio	Equipment	Scaffold	Turf	Timber
Risingham	5040.10336	8679.35038	39956.4247	4794770.96	479477	399564.247	799128.4941	347174.015	0
Newstead	10737.1718	22910.6886	96247.9268	11549751.2	1154975	962479.268	1924958.537	916427.545	0

Stone	Cost in £'s	Construc. Units
2520051.68	9340166.5	934016.65
5368585.92	21877177.62	2187717.76

With Inchtunthil Ratio

Fort	Stone Vol	Turf Vol	Prob. Total	Labour	Supervisio	Equipment	Scaffold	Turf	Timber
Risingham	29736.6098	8679.35038	103582.015	12429841.8	1242984	1035820.15	2071640.308	347174.015	0
Newstead	63349.3139	22910.6886	219000.598	26280071.8	2628007	2190005.98	4380011.967	916427.545	0

Stone	Cost in £'s	Construc. Units
14868304.9	31995765.43	3199576.54
31674657	68069181.43	6806918.14

§ A4.10 | Robin Hood's Butt: Volume, Labour and Survey

Robin Hood's Butt

Volume

Name	Type 1 Tap	Type 2 Tap	Type 3 Tap	Type 1 NT	Type 2 NT	Type 3 NT
RHB	233.053189	250.712539	268.371889	291.958502	324.852	357.745467

Labour — Core/Facing ratios assumed same as HW turrets

Turret		Haulage		Building		Mortar			
Name	Type1 Tap. V	Low	High	Low	High	Low	High	Shaping	Scaffold
RHB	233.053189	310.737585	93.2212756	20.6019019	41.2038	520.174718	1040.349436	162.554599	69.306667

Building Times

Turret	Prob. Total	Build Team	Est Comp. Time
RHB	865.859162	8	108.232395

QUANTITATIVE SURVEY

Labour	Supervision	Turf	Timber	Stone	Equipment	Scaffold
120	12	40	150	500	10	20

Turret	Stone Vol	Prob. Total	Labour	Supervision	Equipment	Scaffold	Stone	Cost in £'s	Con. Units
RHB	233.053189	865.859162	103903.099	10390.3099	8658.59	2600.87359	116526.5945	242079.469	24207.947

Appendix 5 | Chronology

§ A5.1 | Introduction

This appendix contains the information relating to the chronology of construction for the Wall. It is based around Breeze and Dobson's chronology[1] and uses the quantitative calculations to estimate how much labour was needed per season.

[1] See Tables 4.11 and 6.25; Breeze & Dobson, 2000, 86-7, Table 7.

§ A5.2 | A.D.122

Table A5.1				
Area	Feature	Labour	Duration	Personnel
Stone Wall	Wall mile 4	58,589.07	1 season	292.95
	Wall mile 5	58,589.07	1 season	292.95
	Wall mile 6	58,589.07	1 season	292.95
	MC4	6,359.11	1 season	31.80
	MC5	6,359.11	1 season	31.80
	MC6	6,359.11	1 season	31.80
	T4a	534.52	1 season	2.67
	T4b	534.52	1 season	2.67
	T5a	534.52	1 season	2.67
	T5b	534.52	1 season	2.67
	T6a	534.52	1 season	2.67
	T6b	534.52	1 season	2.67
Total	-	198,051.64	-	990.26

Table A5.1: Labour required in A.D.122.

§ A5.3 | A.D.123

Table A5.2				
Area	Feature	Labour	Duration	Personnel
Stone Wall	Wall Mile 7	58,589.07	1 season	292.95
	Wall Mile 8	58,589.07	1 season	292.95
	Wall Mile 9	58,589.07	1 season	292.95
	Wall Mile 10	58,589.07	1 season	292.95
	Wall Mile 11	58,589.07	1 season	292.95
	Wall Mile 12	58,589.07	1 season	292.95
	Wall Mile 13	58,589.07	1 season	292.95
	Wall Mile 14	58,589.07	1 season	292.95
	Wall Mile 15	58,589.07	1 season	292.95
	Wall Mile 16	58,589.07	1 season	292.95
	Wall Mile 17	58,589.07	1 season	292.95
	Wall Mile 18	58,589.07	1 season	292.95
	Wall Mile 19	58,589.07	1 season	292.95
	Wall Mile 20	58,589.07	1 season	292.95
	Wall Mile 21	58,589.07	1 season	292.95
	MC 7	6,359.11	1 season	31.80
	MC8	6,359.11	1 season	31.80
	MC9	6,136.54	1 season	30.68
	MC10	6,244.98	1 season	31.22
	MC11	6,359.11	1 season	31.80
	MC12	6,359.11	1 season	31.80
	MC13	5,922.04	1 season	29.61
	MC14	6,359.11	1 season	31.80
	MC15	6,359.11	1 season	31.80
	MC16	6,359.11	1 season	31.80
	MC17	5,874.12	1 season	29.37
	MC18	5,998.73	1 season	29.99

Table A5.2				
	MC19	5,816.20	1 season	29.08
	MC20	5,815.18	1 season	29.08
	MC21	6,359.11	1 season	31.80
	T7a	534.52	1 season	2.67
	T7b	493.34	1 season	2.47
	T8a	534.52	1 season	2.67
	T8b	534.52	1 season	2.67
	T9a	534.52	1 season	2.67
	T9b	534.52	1 season	2.67
	T10a	540.07	1 season	2.70
	T10b	534.52	1 season	2.67
	T11a	534.52	1 season	2.67
	T11b	534.52	1 season	2.67
	T12a	654.77	1 season	3.27
	T12b	654.77	1 season	3.27
	T13a	654.77	1 season	3.27
	T13b	534.52	1 season	2.67
	T14a	534.52	1 season	2.67
	T14b	534.52	1 season	2.67
	T15a	534.52	1 season	2.67
	T15b	534.52	1 season	2.67
	T16a	534.52	1 season	2.67
	T16b	534.52	1 season	2.67
	T17a	530.20	1 season	2.65
	T17b	609.96	1 season	3.05
	T18a	520.47	1 season	2.60
	T18b	465.42	1 season	2.33
	T19a	629.38	1 season	3.15
	T19b	569.33	1 season	2.85
	T20a	534.52	1 season	2.67

Table A5.2				
	T20b	534.52	1 season	2.67
	T21a	534.52	1 season	2.67
	T21b	534.52	1 season	2.67
Sub-Total	-	987,994.99	-	4,939.97
Turf Wall	TW Mile 49	44,964.83	1 season	224.82
	TW Mile 50	44,964.83	1 season	224.82
	TW Mile 51	44,964.83	1 season	224.82
	TW Mile 52	44,964.83	1 season	224.82
	TW Mile 53	44,964.83	1 season	224.82
	TW Mile 54	44,964.83	1 season	224.82
	TW Mile 55	44,964.83	1 season	224.82
	TW Mile 56	44,964.83	1 season	224.82
	TW Mile 57	44,964.83	1 season	224.82
	TW Mile 58	44,964.83	1 season	224.82
	TW Mile 59	44,964.83	1 season	224.82
	TW Mile 60	44,964.83	1 season	224.82
	TW Mile 61	44,964.83	1 season	224.82
	TW Mile 62	44,964.83	1 season	224.82
	TW Mile 63	44,964.83	1 season	224.82
	TW Mile 64	44,964.83	1 season	224.82
	TW MC 49	4,270.68	1 season	21.35
	TW MC 50	4,623.97	1 season	23.12
	TW MC 51	4,270.68	1 season	21.35
	TW MC 52	4,270.68	1 season	21.35
	TW MC 53	4,270.68	1 season	21.35
	TW MC 54	4,270.68	1 season	21.35
	TW MC 55	4,270.68	1 season	21.35
	TW MC 56	4,270.68	1 season	21.35
	TW MC 57	4,270.68	1 season	21.35
	TW MC 58	4,270.68	1 season	21.35

Table A5.2				
	TW MC 59	4,270.68	1 season	21.35
	TW MC 60	4,270.68	1 season	21.35
	TW MC 61	4,270.68	1 season	21.35
	TW MC 62	4,270.68	1 season	21.35
	TW MC 63	4,270.68	1 season	21.35
	TW MC 64	4,270.68	1 season	21.35
	T49a	523.41	1 season	2.62
	T49b	523.41	1 season	2.62
	T50a	483.03	1 season	2.41
	T50b	510.18	1 season	2.55
	T51a	474.75	1 season	2.37
	T51b	523.41	1 season	2.62
	T52a	440.20	1 season	2.20
	T52b	523.41	1 season	2.62
	T53a	472.17	1 season	2.36
	T53b	523.41	1 season	2.62
	T54a	683.98	1 season	3.42
	T54a(i)	592.95	1 season	2.96
	T54b	523.41	1 season	2.62
	T55a	523.41	1 season	2.62
	T55b	523.41	1 season	2.62
	T56a	523.41	1 season	2.62
	T56b	523.41	1 season	2.62
	T57a	523.41	1 season	2.62
	T57b	523.41	1 season	2.62
	T58a	523.41	1 season	2.62
	T58b	523.41	1 season	2.62
	T59a	523.41	1 season	2.62
	T59b	523.41	1 season	2.62
	T60a	523.41	1 season	2.62

Table A5.2				
	T60b	523.41	1 season	2.62
	T61a	523.41	1 season	2.62
	T61b	523.41	1 season	2.62
	T62a	523.41	1 season	2.62
	T62b	523.41	1 season	2.62
	T63a	523.41	1 season	2.62
	T63b	523.41	1 season	2.62
	T64a	523.41	1 season	2.62
	T64b	523.41	1 season	2.62
Sub-Total	-	805,387.31	-	4,026.88
Cumberland Coast	CC Ditches	1,001.02	1 season	5.01
	CC MF 1	4,891.79	1 season	24.46
	CC MF 2	5,648.15	1 season	28.24
	CC MF 3	5,648.15	1 season	28.24
	CC MF 4	5,648.15	1 season	28.24
	CC MF 5	7,909.92	1 season	39.55
	CC MF 11	5,648.15	1 season	28.24
	CC MF 12	5,648.15	1 season	28.24
	CC MF 13	5,648.15	1 season	28.24
	CC MF 14	5,648.15	1 season	28.24
	CC MF 15	5,648.15	1 season	28.24
	CC MF 16	5,648.15	1 season	28.24
	CC MF 17	5,648.15	1 season	28.24
	CC MF 18	5,648.15	1 season	28.24
	CC MF 19	5,648.15	1 season	28.24
	CC MF 20	4,767.25	1 season	23.84
	CC T1a	538.02	1 season	2.69
	CC T1b	538.02	1 season	2.69
	CC T2a	538.02	1 season	2.69
	CC T2b	538.02	1 season	2.69

Table A5.2				
	CC T3a	480.79	1 season	2.40
	CC T3b	550.52	1 season	2.75
	CC T4a	538.02	1 season	2.69
	CC T4b	538.02	1 season	2.69
	CC T5a	538.02	1 season	2.69
	CC T5b	538.02	1 season	2.69
	CC T11a	538.02	1 season	2.69
	CC T11b	538.02	1 season	2.69
	CC T12a	530.89	1 season	2.65
	CC T12b	538.02	1 season	2.69
	CC T13a	596.01	1 season	2.98
	CC T13b	586.23	1 season	2.93
	CC T14a	538.02	1 season	2.69
	CC T14b	538.02	1 season	2.69
	CC T15a	500.29	1 season	2.50
	CC T15b	538.02	1 season	2.69
	CC T16a	575.02	1 season	2.88
	CC T16b	465.73	1 season	2.33
	CC T17a	538.02	1 season	2.69
	CC T17b	538.02	1 season	2.69
	CC T18a	538.02	1 season	2.69
	CC T18b	538.02	1 season	2.69
	CC T19a	538.02	1 season	2.69
	CC T19b	538.02	1 season	2.69
Sub-Total	-	101,393.54	-	506.97
Forts	Bewcastle	127,896.15	8 seasons	79.94
	Netherby	115,763.72	8 seasons	72.35
	Birrens	103,631.29	8 seasons	64.77
Sub-Total	-	347,291.16	-	217.06
Total	-	2,242,067.01	-	9,690.88

Table A5.2: Labour required in A.D.123.

§ A5.4 | A.D.124

Table A5.3				
Area	Feature	Labour	Duration	Personnel
Stone Wall	Wall Mile 22	43,395.31	5 seasons	43.40
	Wall Mile 23	43,395.31	5 seasons	43.40
	Wall Mile 24	43,395.31	5 seasons	43.40
	Wall Mile 25	43,395.31	5 seasons	43.40
	Wall Mile 26	43,395.31	5 seasons	43.40
	Wall Mile 27	43,395.31	5 seasons	43.40
	Wall Mile 28	49,578.82	5 seasons	49.58
	Wall Mile 29	49,578.82	5 seasons	49.58
	Wall Mile 30	49,578.82	5 seasons	49.58
	Wall Mile 31	49,578.82	5 seasons	49.58
	Wall Mile 32	49,578.82	5 seasons	49.58
	Wall Mile 33	49,578.82	5 seasons	49.58
	Wall Mile 34	49,578.82	5 seasons	49.58
	Wall Mile 35	49,578.82	5 seasons	49.58
	Wall Mile 36	49,578.82	5 seasons	49.58
	Wall Mile 37	49,578.82	5 seasons	49.58
	Wall Mile 38	49,578.82	5 seasons	49.58
	Wall Mile 39	49,578.82	5 seasons	49.58
	Wall Mile 40	49,578.82	5 seasons	49.58
	Wall Mile 41	49,578.82	5 seasons	49.58
	Wall Mile 42	49,578.82	5 seasons	49.58
	Wall Mile 43	49,578.82	5 seasons	49.58
	Wall Mile 44	49,578.82	5 seasons	49.58
	Wall Mile 45	38,904.10	5 seasons	38.90
	Wall Mile 46	38,904.10	5 seasons	38.90
	Wall Mile 47	38,904.10	5 seasons	38.90
	Wall Mile 48	47,946.39	5 seasons	47.95

Table A5.3				
	Wall Mile 49	38,904.10	5 seasons	38.90
	MC 22	6,359.11	5 seasons	6.36
	MC 23	6,359.11	5 seasons	6.36
	MC 24	6,359.11	5 seasons	6.36
	MC 25	6,359.11	5 seasons	6.36
	MC 26	6,359.11	5 seasons	6.36
	MC 27	6,195.62	5 seasons	6.20
	MC 28	6,359.11	5 seasons	6.36
	MC 29	5,769.76	5 seasons	5.77
	MC 30	5,827.43	5 seasons	5.83
	MC 31	6,359.11	5 seasons	6.36
	MC 32	6,359.11	5 seasons	6.36
	MC 33	6,394.08	5 seasons	6.39
	MC 34	6,359.11	5 seasons	6.36
	MC 35	6,359.11	5 seasons	6.36
	MC 36	6,359.11	5 seasons	6.36
	MC 37	5,889.81	5 seasons	5.89
	MC 38	6,076.25	5 seasons	6.08
	MC 39	5,593.20	5 seasons	5.59
	MC 40	5,515.51	5 seasons	5.52
	MC 41	6,359.11	5 seasons	6.36
	MC 42	5,894.01	5 seasons	5.89
	MC 43	6,359.11	5 seasons	6.36
	MC 44	6,359.11	5 seasons	6.36
	MC 45	6,359.11	5 seasons	6.36
	MC 46	6,359.11	5 seasons	6.36
	MC 47	9,660.84	5 seasons	9.66
	MC 48	9,612.92	5 seasons	9.61
	MC 49	6,585.85	5 seasons	6.59
	T22a	534.52	5 seasons	0.53

Table A5.3				
	T22b	534.52	5 seasons	0.53
	T23a	534.52	5 seasons	0.53
	T23b	534.52	5 seasons	0.53
	T24a	534.52	5 seasons	0.53
	T24b	534.52	5 seasons	0.53
	T25a	534.52	5 seasons	0.53
	T25b	538.12	5 seasons	0.54
	T26a	605.11	5 seasons	0.61
	T26b	443.73	5 seasons	0.44
	T27a	534.52	5 seasons	0.53
	T27b	534.52	5 seasons	0.53
	T28a	534.52	5 seasons	0.53
	T28b	534.52	5 seasons	0.53
	T29a	534.52	5 seasons	0.53
	T29b	496.40	5 seasons	0.50
	T30a	534.52	5 seasons	0.53
	T30b	534.52	5 seasons	0.53
	T31a	534.52	5 seasons	0.53
	T31b	534.52	5 seasons	0.53
	T32a	534.52	5 seasons	0.53
	T32b	534.52	5 seasons	0.53
	T33a	534.52	5 seasons	0.53
	T33b	502.32	5 seasons	0.50
	T34a	490.00	5 seasons	0.49
	T34b	534.52	5 seasons	0.53
	T35a	536.24	5 seasons	0.54
	T35b	534.52	5 seasons	0.53
	T36a	534.52	5 seasons	0.53
	T36b	534.52	5 seasons	0.53
	T37a	534.52	5 seasons	0.53

Table A5.3				
	T37b	534.52	5 seasons	0.53
	T38a	534.52	5 seasons	0.53
	T38b	534.52	5 seasons	0.53
	T39a	454.16	5 seasons	0.45
	T39b	437.57	5 seasons	0.44
	T40a	534.52	5 seasons	0.53
	T40b	534.52	5 seasons	0.53
	T41a	520.09	5 seasons	0.52
	T41b	534.52	5 seasons	0.53
	T42a	534.52	5 seasons	0.53
	T42b	534.52	5 seasons	0.53
	T43a	534.52	5 seasons	0.53
	T43b	534.52	5 seasons	0.53
	T44a	534.52	5 seasons	0.53
	T44b	584.75	5 seasons	0.58
	T45a	526.17	5 seasons	0.53
	T45b	496.35	5 seasons	0.50
	T46a	534.52	5 seasons	0.53
	T46b	534.52	5 seasons	0.53
	T47a	534.52	5 seasons	0.53
	T47b	534.52	5 seasons	0.53
	T48a	485.70	5 seasons	0.49
	T48b	437.70	5 seasons	0.44
	T49a	534.52	5 seasons	0.53
	T49b	534.52	5 seasons	0.53
Sub -Total	-	1,517,005.13	-	1,517.01
Turf Wall	TW Mile 65	44,964.83	1 season	224.82
	TW Mile 66	44,964.83	1 season	224.82
	TW Mile 67	44,964.83	1 season	224.82
	TW Mile 68	44,964.83	1 season	224.82

Table A5.3				
	TW Mile 69	44,964.83	1 season	224.82
	TW Mile 70	44,964.83	1 season	224.82
	TW Mile 71	44,964.83	1 season	224.82
	TW Mile 72	44,964.83	1 season	224.82
	TW Mile 73	44,964.83	1 season	224.82
	TW Mile 74	44,964.83	1 season	224.82
	TW Mile 75	44,964.83	1 season	224.82
	TW Mile 76	44,964.83	1 season	224.82
	TW Mile 77	44,964.83	1 season	224.82
	TW Mile 78	44,964.83	1 season	224.82
	TW Mile 79	44,964.83	1 season	224.82
	TW MC 65	4,270.68	1 season	21.35
	TW MC 66	4,270.68	1 season	21.35
	TW MC 67	4,270.68	1 season	21.35
	TW MC 68	4,270.68	1 season	21.35
	TW MC 69	4,270.68	1 season	21.35
	TW MC 70	4,270.68	1 season	21.35
	TW MC 71	4,270.68	1 season	21.35
	TW MC 72	4,270.68	1 season	21.35
	TW MC 73	4,270.68	1 season	21.35
	TW MC 74	4,270.68	1 season	21.35
	TW MC 75	4,270.68	1 season	21.35
	TW MC 76	4,270.68	1 season	21.35
	TW MC 77	4,270.68	1 season	21.35
	TW MC 78	4,270.68	1 season	21.35
	TW MC 79	3,917.38	1 season	19.59
	TW T65a	523.41	1 season	2.62
	TW T65b	523.41	1 season	2.62
	TW T66a	523.41	1 season	2.62
	TW T66b	523.41	1 season	2.62

Table A5.3				
	TW T67a	523.41	1 season	2.62
	TW T67b	523.41	1 season	2.62
	TW T68a	523.41	1 season	2.62
	TW T68b	523.41	1 season	2.62
	TW T69a	523.41	1 season	2.62
	TW T69b	523.41	1 season	2.62
	TW T70a	523.41	1 season	2.62
	TW T70b	523.41	1 season	2.62
	TW T71a	523.41	1 season	2.62
	TW T71b	523.41	1 season	2.62
	TW T72a	523.41	1 season	2.62
	TW T72b	518.42	1 season	2.59
	TW T73a	523.41	1 season	2.62
	TW T73b	523.41	1 season	2.62
	TW T74a	523.41	1 season	2.62
	TW T74b	523.41	1 season	2.62
	TW T75a	523.41	1 season	2.62
	TW T75b	523.41	1 season	2.62
	TW T76a	523.41	1 season	2.62
	TW T76b	523.41	1 season	2.62
	TW T77a	523.41	1 season	2.62
	TW T77b	523.41	1 season	2.62
	TW T78a	523.41	1 season	2.62
	TW T78b	523.41	1 season	2.62
	TW T79a	523.41	1 season	2.62
	TW T79b	535.00	1 season	2.68
	TW T80a	523.41	1 season	2.62
Sub -Total	-	754,411.61	-	3,772.06
Cumberland Coast	CC MF 20	4,767.25	1 season	23.84

Table A5.3				
	CC MF 21	4,684.00	1 season	23.42
	CC MF 22	5,987.77	1 season	29.94
	CC MF 23	5,648.15	1 season	28.24
	CC MF 24	5,648.15	1 season	28.24
	CC MF 25	5,648.15	1 season	28.24
	CC MF 26	5,648.15	1 season	28.24
	CC MF 27	5,648.15	1 season	28.24
	CC MF 28	5,648.15	1 season	28.24
	CC MF 29	5,648.15	1 season	28.24
	CC MF 30	5,648.15	1 season	28.24
	CC MF 31	5,648.15	1 season	28.24
	CC MF 32	5,648.15	1 season	28.24
	CC MF 33	5,648.15	1 season	28.24
	CC MF 34	5,648.15	1 season	28.24
	CC MF 34	5,648.15	1 season	28.24
	CC MF 35	5,648.15	1 season	28.24
	CC MF 36	5,648.15	1 season	28.24
	CC MF 37	5,648.15	1 season	28.24
	CC MF 38	5,648.15	1 season	28.24
	CC MF 39	5,648.15	1 season	28.24
	CC MF 40	5,648.15	1 season	28.24
	CC T20a	538.02	1 season	2.69
	CC T20b	593.82	1 season	2.97
	CC T21a	538.02	1 season	2.69
	CC T21b	533.33	1 season	2.67
	CC T22a	538.02	1 season	2.69
	CC T22b	538.02	1 season	2.69
	CC T23a	538.02	1 season	2.69
	CC T23b	538.02	1 season	2.69
	CC T24a	538.02	1 season	2.69

Table A5.3				
	CC T24b	538.02	1 season	2.69
	CC T25a	538.02	1 season	2.69
	CC T25b	538.02	1 season	2.69
	CC T26a	505.53	1 season	2.53
	CC T26b	538.02	1 season	2.69
	CC T27a	538.02	1 season	2.69
	CC T27b	538.02	1 season	2.69
	CC T28a	538.02	1 season	2.69
	CC T28b	538.02	1 season	2.69
	CC T29a	538.02	1 season	2.69
	CC T29b	538.02	1 season	2.69
	CC T30a	538.02	1 season	2.69
	CC T30b	538.02	1 season	2.69
	CC T31a	538.02	1 season	2.69
	CC T31b	538.02	1 season	2.69
	CC T32a	538.02	1 season	2.69
	CC T32b	538.02	1 season	2.69
	CC T33a	538.02	1 season	2.69
	CC T33b	538.02	1 season	2.69
	CC T34a	538.02	1 season	2.69
	CC T34b	538.02	1 season	2.69
	CC T35a	538.02	1 season	2.69
	CC T35b	538.02	1 season	2.69
	CC T36a	538.02	1 season	2.69
	CC T26b	538.02	1 season	2.69
	CC T37a	538.02	1 season	2.69
	CC T37b	538.02	1 season	2.69
	CC T38a	538.02	1 season	2.69
	CC T38b	538.02	1 season	2.69
	CC T39a	538.02	1 season	2.69

Table A5.3				
	CC T39b	538.02	1 season	2.69
	CC T40a	538.02	1 season	2.69
	CC T40b	538.02	1 season	2.69
Sub -Total	-	145,369.11	-	726.85
Forts	Continued	347,291.16		217.06
	Wallsend	122,891.88	7 seasons	87.78
	Benwell	111,656.04	7 seasons	79.75
	Rudchester	101,706.25	7 seasons	72.65
	Halton Chesters	117,880.05	7 seasons	84.20
	Chesters	133,386.21	7 seasons	95.28
	Housesteads	118,098.62	7 seasons	84.36
	Great Chesters	112,073.17	7 seasons	80.05
	Carvoran	112,431.11	7 seasons	80.31
	Birdoswald	65,376.97	7 seasons	46.70
	Castlesteads	65,376.97	7 seasons	46.70
	Stanwix	65,376.97	7 seasons	46.70
	Burgh-by-Sands	65,376.97	7 seasons	46.70
	Drumburgh	65,376.97	7 seasons	46.70
	Bowness	65,376.97	7 seasons	46.70
	Beckfoot	88,356.56	7 seasons	63.11
	Maryport	126,305.82	7 seasons	90.22
Sub -Total	-	1,884,338.68	-	1,314.95
Earthworks	Vallum	1,000,603.61	4 seasons	1,250.75
	Ditch	147,350.22	4 seasons	184.19
Sub-Total	-	1,147,953.83	-	1,434.94
Total	-	5,449,078.36	-	8,765.80

Table A5.3: Labour required in A.D.124.

§ A5.5 | A.D.125

Table A5.4				
Area	Feature	Labour	Duration	Personnel
Stone Wall	Continued	1,517,005.13		1,517.01
Forts	Continued	1,884,338.68		1,314.95
Vallum and Ditch	Continued	1,147,953.83		1,434.94
Total	-	4,549,297.64	-	4,266.90

Table A5.4: Labour required in A.D.125.

§ A5.6 | A.D.126

Table A5.5				
Area	Feature	Labour	Duration	Personnel
Stone Wall	Continued	1,517,005.13		1,517.01
Forts	Continued	1,884,338.68		1,314.95
Vallum and Ditch	Continued	1,147,953.83		1,434.94
Total	-	4,549,297.64	-	4,266.90

Table A5.5: Labour required in A.D.126.

§ A5.7 | A.D.127

Table A5.6				
Area	Feature	Labour	Duration	Personnel
Stone Wall	Continued	1,517,005.13		1,517.01
	Seg - P.Ael SW	173,967.72	2 seasons	434.92
	MC 1	6,359.11	2 seasons	15.90
	MC 2	6,359.11	2 seasons	15.90
	MC 3	6,359.11	2 seasons	15.90
	T1a	534.52	2 seasons	1.34
	T1b	534.52	2 seasons	1.34
	T2a	534.52	2 seasons	1.34
	T2b	534.52	2 seasons	1.34
	T3a	534.52	2 seasons	1.34
	T3b	534.52	2 seasons	1.34
Sub-Total	-	1,713,257.28	-	2,007.64
Forts	Continued	1,884,338.68		1,314.95
Vallum and Ditch	Continued	1,147,953.83		1,434.94
Total	-	4,745,549.79	-	4,757.53

Table A5.6: Labour required in A.D.127.

§ A5.8 | A.D.128

Table A5.7				
Area	Feature	Labour	Duration	Personnel
Stone Wall	Continued	1,713,257.28		2,007.64
Forts	Continued	1,884,338.68		1,314.95
Total	-	3,597,595.96	-	3,322.58

Table A5.7: Labour required in A.D.128.

§ A5.9 | A.D.129

Table A5.8				
Area	Feature	Labour	Duration	Personnel
Forts	Continued	1,884,338.68		1,314.95
Total	-	1,884,338.68	-	1,314.95

Table A5.8: Labour required in A.D.129.

§ A5.10 | A.D.130

Table A5.9				
Area	Feature	Labour	Duration	Personnel
Forts	Continued	1,884,338.68		1,314.95
Total	-	1,884,338.68	-	1,314.95

Table A5.9: Labour required in A.D.130.

Appendix 6 | Supply

§ A6.1 | Introduction

This is the data appendix for calculating the supply demand of the personnel building the Wall. This covers the demands of the soldiery, the non-combatants, their draft animals and animals kept for consumption as part of the meat ration. The calculations include the amount of food required, as well as the land and labour needed to supply this demand.

§ A6.2 | Numbers of Personnel and Draft Animals

	122	123	124	125	126	127	128	129	130
Soldiers	991	9691	8766	4267	4267	4758	3323	1315	1315
Non Combatants	248	2423	2192	1067	1067	1190	831	329	329
Work Animals	413	4038	3653	1778	1778	1983	1385	548	548

§ A6.3 | Total Grain Supply Required Per Year

		122	123	124	125	126	127	128	129	130
Grain	Soldier Ration/Yr	307.45775	3006.63275	2718.10025	1323.83675	1323.83675	1476.1695	1030.96075	407.97875	407.97875
	NonCom Ration/	76.942	751.73575	679.75775	331.03675	331.03675	369.1975	257.81775	102.07225	102.07225
	Animals Hard/Yr	301.49	2947.74	2665.23	1297.94	1297.94	1447.59	1011.05	400.04	400.04
	Animals Green/Y	904.47	8843.22	7995.69	3893.82	3893.82	4342.77	3033.15	1200.12	1200.12
	Animals Total Gra	1205.96	11790.96	10660.92	5191.76	5191.76	5790.36	4044.2	1600.16	1600.16
	Animals Pasture/	1808.94	17686.44	15991.38	7787.64	7787.64	8685.54	6066.3	2400.24	2400.24
	Total Sol/NC/Ani	1590.35975	15549.3285	14058.778	6846.6335	6846.6335	7635.727	5332.9785	2110.211	2110.211

§ A6.4 | Meat Ration and Number of Animals for Consumption

		122	123	124	125	126	127	128	129	130
Meat	Soldier Ration/Yr	58.959545	576.566045	521.235695	253.865165	253.865165	283.07721	197.701885	78.235925	78.235925
	NonCom Ration/\	14.75476	144.156385	130.353545	63.481165	63.481165	70.79905	49.440345	19.573855	19.573855
	Animals/Soldiers	671.13881616392	6563.0739328401	5933.246385885	2889.7571428571	2889.7571428571	3222.2789982925	2250.4483210017	890.56260671599	890.562606716
	Animals/Non-Cor	167.95401252134	1640.9377916904	1483.8195219124	722.60859419465	722.60859419465	805.90836653386	562.78138873079	222.80996015936	222.8099601594
	Total Meat Anima	839.09282868526	8204.0117245305	7417.0659077974	3612.3657370518	3612.3657370518	4028.1873648264	2813.2297097325	1113.3725668754	1113.372566875
	Meat Animals Ha	854.49018209163	8354.5553396756	7553.1690672055	3678.6526483267	3678.6526483267	4102.104602971	2864.8524749061	1133.8029534775	1133.802953478
	Meat Animals Gre	1332.269638745	13025.919615623	11776.446395105	5735.533699004	5735.533699004	6395.7544885031	4466.7054716278	1767.7572930564	1767.757293056
	Meat Animals Pa	2664.53927749	26051.839231246	23552.892790211	11471.067398008	11471.067398008	12791.508977006	8933.4109432556	3535.5145861127	3535.514586113
	Meat Animals Tot	2186.7598208367	21380.474955299	19329.615462311	9414.1863473307	9414.1863473307	10497.859091474	7331.5579465339	2901.5602465339	2901.560246534
50% Supply	Meat Animals	420	4103	3709	1807	1807	2015	1407	557	557
	Meat Animals Ha	427.707	4178.29005	3777.06015	1840.15845	1840.15845	2051.97525	1432.81845	567.22095	567.22095
	Meat Animals Gre	666.855	6514.53825	5888.96475	2869.06425	2869.06425	3199.31625	2233.96425	884.37675	884.37675
	Meat Animals Pa	1333.71	13029.0765	11777.9295	5738.1285	5738.1285	6398.6325	4467.9285	1768.7535	1768.7535
	Meat Animals Tot	1094.562	10692.8283	9666.0249	4709.2227	4709.2227	5251.2915	3666.7827	1451.5977	1451.5977

§ A6.5 | Grain Demand of Meat Animals

Year	Meat Animal Num	June	July	August	September	October	November	December	January	February	March	April	May	TOTAL	Grain Totals
122	420	420	385	350	315	280	245	210	175	140	105	70	35		
	Hard Fodder	35.64225	32.6720625	29.701875	26.7316875	23.7615	20.7913125	17.821125	14.8509375	11.88075	8.9105625	5.940375	2.9701875	231.674625	
	Green Fodder	55.57125	50.9403125	46.309375	41.6784375	37.0475	32.4165625	27.785625	23.1546875	18.52375	13.8928125	9.261875	4.6309375	361.213125	592.88775
	Pasturage	111.1425	101.880625	92.61875	83.356875	74.095	64.833125	55.57125	46.309375	37.0475	27.785625	18.52375	9.261875	722.42625	
123	4103	4103	3761.0833333333	3419.1666666667	3077.25	2735.3333333333	2393.4166666667	2051.5	1709.5833333333	1367.6666666667	1025.75	683.83333333333	341.91666666667		
	Hard Fodder	348.1908375	319.174934375	290.15903125	261.143128125	232.127225	203.111321875	174.09541875	145.079515625	116.0636125	87.047709375	58.03180625	29.015903125	2263.24044375	
	Green Fodder	542.8781875	497.63833854167	452.39848958333	407.158640625	361.91879166667	316.67894270833	271.43909375	226.19924479167	180.95939583333	135.719546875	90.479697916667	45.239848958333	3528.70821875	5791.9486625
	Pasturage	1085.756375	995.27667708333	904.79697916667	814.31728125	723.83758333333	633.35788541667	542.8781875	452.39848958333	361.91879166667	271.43909375	180.95939583333	90.479697916667	7057.4164375	
124	3709	3709	3399.9166666667	3090.8333333333	2781.75	2472.6666666667	2163.5833333333	1854.5	1545.4166666667	1236.3333333333	927.25	618.16666666667	309.08333333333		
	Hard Fodder	314.7550125	288.525428125	262.29584375	236.066259375	209.836675	183.607090625	157.37750625	131.147921875	104.9183375	78.688753125	52.45916875	26.229584375	2045.90758125	
	Green Fodder	490.7470625	449.85147395833	408.95588541667	368.060296875	327.16470833333	286.26911979167	245.37353125	204.47794270833	163.58235416667	122.686765625	81.791177083333	40.895588541667	3189.85590625	5235.7634875
	Pasturage	981.494125	899.70294791667	817.91177083333	736.12059375	654.32941666667	572.53823958333	490.7470625	408.95588541667	327.16470833333	245.37353125	163.58235416667	81.791177083333	6379.7118125	
125	1807	1807	1656.4166666667	1505.8333333333	1355.25	1204.6666666667	1054.0833333333	903.5	752.91666666667	602.33333333333	451.75	301.16666666667	150.58333333333		
	Hard Fodder	153.3465375	140.567659375	127.78878125	115.009903125	102.231025	89.452146875	76.67326875	63.894390625	51.1155125	38.336634375	25.55775625	12.778878125	996.75249375	
	Green Fodder	239.0886875	219.16463020833	199.24057291667	179.316515625	159.39245833333	139.46840104167	119.54434375	99.620286458333	79.696229166667	59.772171875	39.848114583333	19.924057291667	1554.07646875	2550.8289625
	Pasturage	478.177375	438.32926041667	398.48114583333	358.63303125	318.78491666667	278.93680208333	239.0886875	199.24057291667	159.39245833333	119.54434375	79.696229166667	39.848114583333	3108.1529375	
126	1807	1807	1656.4166666667	1505.8333333333	1355.25	1204.6666666667	1054.0833333333	903.5	752.91666666667	602.33333333333	451.75	301.16666666667	150.58333333333		
	Hard Fodder	153.3465375	140.567659375	127.78878125	115.009903125	102.231025	89.452146875	76.67326875	63.894390625	51.1155125	38.336634375	25.55775625	12.778878125	996.75249375	
	Green Fodder	239.0886875	219.16463020833	199.24057291667	179.316515625	159.39245833333	139.46840104167	119.54434375	99.620286458333	79.696229166667	59.772171875	39.848114583333	19.924057291667	1554.07646875	2550.8289625
	Pasturage	478.177375	438.32926041667	398.48114583333	358.63303125	318.78491666667	278.93680208333	239.0886875	199.24057291667	159.39245833333	119.54434375	79.696229166667	39.848114583333	3108.1529375	
127	2015	2015	1847.0833333333	1679.1666666667	1511.25	1343.3333333333	1175.4166666667	1007.5	839.58333333333	671.66666666667	503.75	335.83333333333	167.91666666667		
	Hard Fodder	170.9979375	156.748109375	142.49828125	128.248453125	113.998625	99.748796875	85.49896875	71.249140625	56.9993125	42.749484375	28.49965625	14.249828125	1111.48659375	
	Green Fodder	266.6096875	244.39221354167	222.17473958333	199.957265625	177.73979166667	155.52231770833	133.30484375	111.08736979167	88.869895833333	66.652421875	44.434947916667	22.217473958333	1732.96296875	2844.4495625
	Pasturage	533.219375	488.78442708333	444.34947916667	399.91453125	355.47958333333	311.04463541667	266.6096875	222.17473958333	177.73979166667	133.30484375	88.869895833333	44.434947916667	3465.9259375	
128	1407	1407	1289.75	1172.5	1055.25	938	820.75	703.5	586.25	469	351.75	234.5	117.25		
	Hard Fodder	119.4015375	109.451409375	99.50128125	89.551153125	79.601025	69.650896875	59.70076875	49.750640625	39.8005125	29.850384375	19.90025625	9.950128125	776.10999375	
	Green Fodder	186.1636875	170.650046875	155.13640625	139.622765625	124.109125	108.595484375	93.08184375	77.568203125	62.0545625	46.540921875	31.02728125	15.513640625	1210.06396875	1986.1739625
	Pasturage	372.327375	341.30009375	310.2728125	279.24553125	248.21825	217.19096875	186.1636875	155.13640625	124.109125	93.08184375	62.0545625	31.02728125	2420.1279375	
129	557	557	510.58333333333	464.16666666667	417.75	371.33333333333	324.91666666667	278.5	232.08333333333	185.66666666667	139.25	92.833333333333	46.416666666667		
	Hard Fodder	47.2684125	43.329378125	39.39034375	35.451309375	31.512275	27.573240625	23.63420625	19.695171875	15.7561375	11.817103125	7.87806875	3.939034375	307.24468125	
	Green Fodder	73.6980625	67.556557291667	61.415052083333	55.273546875	49.132041666667	42.990536458333	36.84903125	30.707526041667	24.566020833333	18.424515625	12.283010416667	6.1415052083333	479.03740625	786.2820875
	Pasturage	147.396125	135.11311458333	122.83010416667	110.54709375	98.264083333333	85.981072916667	73.6980625	61.415052083333	49.132041666667	36.84903125	24.566020833333	12.283010416667	958.0748125	
130	557	557	510.58333333333	464.16666666667	417.75	371.33333333333	324.91666666667	278.5	232.08333333333	185.66666666667	139.25	92.833333333333	46.416666666667		
	Hard Fodder	47.2684125	43.329378125	39.39034375	35.451309375	31.512275	27.573240625	23.63420625	19.695171875	15.7561375	11.817103125	7.87806875	3.939034375	307.24468125	
	Green Fodder	73.6980625	67.556557291667	61.415052083333	55.273546875	49.132041666667	42.990536458333	36.84903125	30.707526041667	24.566020833333	18.424515625	12.283010416667	6.1415052083333	479.03740625	786.2820875
	Pasturage	147.396125	135.11311458333	122.83010416667	110.54709375	98.264083333333	85.981072916667	73.6980625	61.415052083333	49.132041666667	36.84903125	24.566020833333	12.283010416667	958.0748125	

§ A6.6 | Land and Labour Needed for Full Supply

Year	Soldiers	Non-Combatants	Work Animals	Meat Animals	Soldier KM^2	NonCom KM^2	Wrk-Anmls Hard	Wrk-Anmls Greer	Meat Hard	Meat Green
122	991	248	413	420	4.571712828179	1.1440815150235	4.9811657386952	13.448927866358	3.8276881640355	5.967900900916
123	9691	2423	4038	4103	44.70683049231	11.177860931056	48.702051459688	131.49339158439	37.392867945328	58.3007080868
124	8761	2191	3651	3709	40.41652481097	10.10759112668	44.034470004785	118.8911274578	33.802131905732	52.70224867023
125	4267	1067	1778	1807	19.68466058309	4.9223184537504	21.444340637773	57.898774204321	16.4681726486	25.6761831618
126	4267	1067	1778	1807	19.68466058309	4.9223184537504	21.444340637773	57.898774204321	16.4681726486	25.6761831618
127	4758	1190	1983	2015	21.94975745356	5.4897459793467	23.916832106132	64.574392152513	18.363789644123	28.63171503654
128	3323	831	1385	1407	15.32976965493	3.8335957217119	16.704393578917	45.101126137787	12.822755349519	19.99246801807
129	1315	329	548	557	6.066399968774	1.5177533001723	6.6093918276149	17.845066515168	5.0762435889709	7.914573337643
130	1315	329	548	557	6.066399968774	1.5177533001723	6.6093918276149	17.845066515168	5.0762435889709	7.914573337643

Year	Total KM^2	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	33.94	45.14	17161.34	1441552.64	180194.08	900.97	720.78
123	331.77	441.26	167749.97	14090997.56	1761374.69	8806.87	7045.50
124	299.95	398.94	151661.48	12739563.96	1592445.50	7962.23	6369.78
125	146.09	194.31	73867.64	6204881.43	775610.18	3878.05	3102.44
126	146.09	194.31	73867.64	6204881.43	775610.18	3878.05	3102.44
127	162.93	216.69	82378.05	6919756.06	864969.51	4324.85	3459.88
128	113.78	151.33	57531.02	4832605.91	604075.74	3020.38	2416.30
129	45.03	59.89	22767.58	1912476.93	239059.62	1195.30	956.24
130	45.03	59.89	22767.58	1912476.93	239059.62	1195.30	956.24

§ A6.7 | Horses: Hard Fodder Full Support and Pasture

Year	Number of Horse	Hard Ration/Yr Round Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	188	171.55	2.8343194881195	3.769644919199	1433.0762103778	120378.40167174	15047.300208967	75.236501044836	60.18920083587
123	1836	1675.35	27.679843511636	36.814191870475	13995.361288584	1175610.348241	146951.29353013	734.75646765064	587.8051741205
124	1660	1514.75	25.026438033396	33.285162584417	12653.758027804	1062915.6743356	132864.45929195	664.32229645973	531.4578371678
125	809	738.2125	12.196619499408	16.221503934213	6166.8013521046	518011.31357679	64751.414197099	323.75707098549	259.0056567884
126	809	738.2125	12.196619499408	16.221503934213	6166.8013521046	518011.31357679	64751.414197099	323.75707098549	259.0056567884
127	902	823.075	13.598703075978	18.086275091051	6875.7167114937	577560.20376547	72195.025470683	360.97512735342	288.7801018827
128	630	574.875	9.4979855186985	12.632320739869	4802.3298539257	403395.70772976	50424.46346622	252.1223173311	201.6978538649
129	250	228.125	3.7690418724994	5.0128256904242	1905.6864499705	160077.66179752	20009.707724691	100.04853862345	80.03883089876
130	250	228.125	3.7690418724994	5.0128256904242	1905.6864499705	160077.66179752	20009.707724691	100.04853862345	80.03883089876

Year	Pasture Ration/ 6 Months no Support	KM^2 Needed	Pasture Ration/ 2 Months Part Support	KM^2 Needed
122	480.34	7.1423684713992	160.11333333333	4.761578980933
123	4690.98	69.752066561111	1563.66	46.50137770741
124	4241.3	63.065593949589	1413.7666666667	42.04372929973
125	2066.995	30.73497922001	688.99833333333	20.48998614667
126	2066.995	30.73497922001	688.99833333333	20.48998614667
127	2304.61	34.268172134054	768.20333333333	22.84544808937
128	1609.65	23.934532643519	536.55	15.95635509568
129	638.75	9.4978304140947	212.91666666667	6.33188694273
130	638.75	9.4978304140947	212.91666666667	6.33188694273

§ A6.8 | Horses: Green Ration

Year	Green Ration/ 2 Months Part Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	40.02833333333	0.5951973726166	0.7916125055801	300.94108965188	25279.051530758	3159.8814413447	15.799407206723	12.63952576538
123	390.915	5.8126722134259	7.7308540438565	2938.9778755364	246874.14154506	30859.267693132	154.29633846566	123.4370707725
124	353.4416666667	5.2554661624657	6.9897699960794	2657.245791607	223208.64649499	27901.080811873	139.50540405937	111.6043232475
125	172.2495833333	2.5612482683342	3.4064601968845	1295.0071357892	108780.59940629	13597.574925786	67.987874628932	54.39029970315
126	172.2495833333	2.5612482683342	3.4064601968845	1295.0071357892	108780.59940629	13597.574925786	67.987874628932	54.39029970315
127	192.0508333333	2.8556810111711	3.7980557448576	1443.8769301383	121285.66213161	15160.707766452	75.803538832258	60.64283106581
128	134.1375	1.9945443869599	2.6527440346566	1008.4728004292	84711.715236049	10588.964404506	52.944822022531	42.35585761802
129	53.22916666667	0.7914858678412	1.0526762042288	400.18761921792	33615.760014305	4201.9700017882	21.009850008941	16.80788000715
130	53.22916666667	0.7914858678412	1.0526762042288	400.18761921792	33615.760014305	4201.9700017882	21.009850008941	16.80788000715

Year	Green Ration/ 4 Months Full Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	160.1133333333	2.3807894904664	3.1664500223203	1203.7643586075	101116.20612303	12639.525765379	63.197628826894	50.55810306152
123	1563.66	23.250688853704	30.923416175426	11755.911502146	987496.56618023	123437.07077253	617.18535386264	493.7482830901
124	1413.766666667	21.021864649863	27.959079984318	10628.983166428	892834.58597995	111604.32324749	558.02161623747	446.41729299
125	688.9983333333	10.244993073337	13.625840787538	5180.0285431567	435122.39762517	54390.299703146	271.95149851573	217.5611988126
126	688.9983333333	10.244993073337	13.625840787538	5180.0285431567	435122.39762517	54390.299703146	271.95149851573	217.5611988126
127	768.2033333333	11.422724044685	15.19222297943	5775.507720553	485142.64852645	60642.831065807	303.21415532903	242.5713242632
128	536.55	7.9781775478395	10.610976138627	4033.8912017166	338846.8609442	42355.857618025	211.77928809012	169.4234304721
129	212.9166666667	3.1659434713649	4.2107048169153	1600.7504768717	134463.04005722	16807.880007153	84.039400035763	67.23152002861
130	212.9166666667	3.1659434713649	4.2107048169153	1600.7504768717	134463.04005722	16807.880007153	84.039400035763	67.23152002861

§ A6.9 | Draft Animals: Pasture

Year	Number of Anima	Pasture Ration/ 6 Months no Support	KM^2 Needed	Pasture Ration/ 2 Months Part Support	KM^2 Needed
122	225	492.75	7.3268977480159	164.25	4.884598498677
123	2202	4822.38	71.705905960582	1607.46	47.80393730705
124	1991	4360.29	64.834904072443	1453.43	43.22326938163
125	969	2122.11	31.554506301455	707.37	21.0363375343
126	969	2122.11	31.554506301455	707.37	21.0363375343
127	1081	2367.39	35.201673180467	789.13	23.46778212031
128	755	1653.45	24.585812443342	551.15	16.39054162889
129	298	652.62	9.7040690173721	217.54	6.469379344915
130	298	652.62	9.7040690173721	217.54	6.469379344915

§ A6.10 | Draft Animals: Part Support

Year	Green Ration/ 2 Months Part Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	41.0625	0.6105748123347	0.8120645004051	308.71616339668	25932.157725321	3241.5197156651	16.207598578326	12.96607886266
123	401.865	5.9754921633818	7.9474045772978	3021.3021857755	253789.38360514	31723.672950643	158.61836475321	126.8946918026
124	363.3575	5.4029086727036	7.1858685346957	2731.7950281013	229470.78236051	28683.847795064	143.41923897532	114.7353911803
125	176.8425	2.6295421917879	3.4972911150779	1329.5376103617	111681.15927038	13960.144908798	69.800724543989	55.84057963519
126	176.8425	2.6295421917879	3.4972911150779	1329.5376103617	111681.15927038	13960.144908798	69.800724543989	55.84057963519
127	197.2825	2.933472765039	3.9015187775018	1483.2096561414	124589.61111588	15573.701389485	77.868506947423	62.29480555794
128	137.7875	2.0488177036119	2.7249275458038	1035.9142371755	87016.795922744	10877.099490343	54.385497451715	43.50839796137
129	54.385	0.8086724181143	1.0755343160921	408.87740752094	34345.702231759	4293.2127789698	21.466063894849	17.17285111588
130	54.385	0.8086724181143	1.0755343160921	408.87740752094	34345.702231759	4293.2127789698	21.466063894849	17.17285111588

Year	Hard Ration/ 2 Months Part Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	13.6875	0.22614251235	0.3007695414255	114.34118699823	9604.6597078515	1200.5824634814	6.0029123174072	4.802329853926
123	133.955	2.2131813875316	2.9435312454171	1119.0190834227	93997.603007506	11749.700375938	58.748501879691	46.99880150375
124	121.1191666667	2.001109964839	2.6614762532359	1011.792459171	84990.566570366	10623.820821296	53.119104106479	42.49528328518
125	58.9475	0.9739204198538	1.2953141584056	492.42937867238	41364.06780848	5170.50847606	25.8525423803	20.68203390424
126	58.9475	0.9739204198538	1.2953141584056	492.42937867238	41364.06780848	5170.50847606	25.8525423803	20.68203390424
127	65.76083333333	1.0864891371125	1.4450305523596	549.34588064484	46145.053974166	5768.1317467708	28.840658733854	23.07252698708
128	45.92916666667	0.7588337636632	1.0092489056721	383.67820526073	32228.969241902	4028.6211552377	20.143105776189	16.11448462095
129	18.12833333333	0.2995131941346	0.398352548199	151.43854989099	12720.838190843	1590.1047738554	7.950523869277	6.360419095422
130	18.12833333333	0.2995131941346	0.398352548199	151.43854989099	12720.838190843	1590.1047738554	7.950523869277	6.360419095422

§ A6.11 | Draft Animals: Full Support

Year	Green Ration/ 4 Months Full Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	164.25	2.4422992493386	3.2482580016204	1234.8646535867	103728.63090129	12966.078862661	64.830394313303	51.86431545064
123	1607.46	23.901968653527	31.789618309191	12085.208743102	1015157.5344206	126894.69180257	634.47345901286	507.5787672103
124	1453.43	21.611634690814	28.743474138783	10927.180112405	917883.12944203	114735.39118025	573.67695590127	458.941564721
125	707.37	10.518168767152	13.989164460312	5318.1504414468	446724.63708153	55840.579635192	279.20289817596	223.3623185408
126	707.37	10.518168767152	13.989164460312	5318.1504414468	446724.63708153	55840.579635192	279.20289817596	223.3623185408
127	789.13	11.733891060156	15.606075110007	5932.8386245655	498358.44446351	62294.805557938	311.47402778969	249.1792222318
128	551.15	8.1952708144474	10.899710183215	4143.6569487021	348067.18369098	43508.397961372	217.54198980686	174.0335918455
129	217.54	3.2346896724574	4.3021372643683	1635.5096300838	137382.80892704	17172.851115879	85.864255579397	68.69140446352
130	217.54	3.2346896724574	4.3021372643683	1635.5096300838	137382.80892704	17172.851115879	85.864255579397	68.69140446352

Year	Hard Ration/ 4 Months Full Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	54.75	0.9045700493999	1.2030781657018	457.36474799293	38418.638831406	4802.3298539257	24.011649269629	19.2093194157
123	535.82	8.8527255501266	11.774124981668	4476.0763336908	375990.41203003	46998.801503753	234.99400751877	187.995206015
124	484.4766666667	8.004439859356	10.645905012944	4047.1698366841	339962.26628146	42495.283285183	212.47641642591	169.9811331407
125	235.79	3.8956816794154	5.1812566336224	1969.7175146895	165456.27123392	20682.03390424	103.4101695212	82.72813561696
126	235.79	3.8956816794154	5.1812566336224	1969.7175146895	165456.27123392	20682.03390424	103.4101695212	82.72813561696
127	263.0433333333	4.34595654845	5.7801222094385	2197.3835225794	184580.21589667	23072.526987083	115.36263493542	92.29010794833
128	183.7166666667	3.0353350546528	4.0369956226883	1534.7128210429	128915.87696761	16114.484620951	80.572423104754	64.4579384838
129	72.5133333333	1.1980527765385	1.5934101927962	605.75419956397	50883.352763373	6360.4190954216	31.802095477108	25.44167638169
130	72.5133333333	1.1980527765385	1.5934101927962	605.75419956397	50883.352763373	6360.4190954216	31.802095477108	25.44167638169

§ A6.12 | Meat Animals: Pasture

Year	Number of Anima	Pasture Ration/ 6 Months no Support	KM^2 Needed	Pasture Ration/ 2 Months Part Support	KM^2 Needed
122	420	416.784375	6.1973343451968	101.880625	3.029807902096
123	4103	4071.58640625	60.542054329386	995.27667708333	29.59833767214
124	3709	3680.60296875	54.728364491273	899.70294791667	26.75608930684
125	1807	1793.16515625	26.663293242311	438.32926041667	13.03538780735
126	1807	1793.16515625	26.663293242311	438.32926041667	13.03538780735
127	2015	1999.57265625	29.73244929898	488.78442708333	14.53586410172
128	1407	1396.22765625	20.761070056409	341.30009375	10.14985647202
129	557	552.73546875	8.2188457863681	135.11311458333	4.018102384447
130	557	552.73546875	8.2188457863681	135.11311458333	4.018102384447

§ A6.13 | Meat Animals: Part Support

Year	Green Ration/ 2 Months Part Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	50.9403125	0.757451975524	1.007411127447	382.97955159155	32170.28233369	4021.2852917113	20.106426458556	16.08514116685
123	497.6383385417	7.3995844180361	9.841447275988	3741.3454766193	314273.02003603	39284.127504503	196.42063752252	157.136510018
124	449.8514739583	6.6890223267112	8.8963996945259	3382.0741829835	284094.23137061	35511.778921326	177.55889460663	142.0471156853
125	219.1646302083	3.258846951838	4.3342664459445	1647.7239279189	138408.80994519	17301.101243148	86.505506215741	69.20440497259
126	219.1646302083	3.258846951838	4.3342664459445	1647.7239279189	138408.80994519	17301.101243148	86.505506215741	69.20440497259
127	244.3922135417	3.6339660254309	4.833174813823	1837.3899915642	154340.75929139	19292.594911424	96.462974557121	77.1703796457
128	170.650046875	2.5374641180056	3.3748272769474	1282.9814978317	107770.44581786	13471.305727233	67.356528636164	53.88522290893
129	67.55655729167	1.0045255961117	1.3360190428285	507.90383389641	42663.922047299	5332.9902559123	26.664951279562	21.33196102365
130	67.55655729167	1.0045255961117	1.3360190428285	507.90383389641	42663.922047299	5332.9902559123	26.664951279562	21.33196102365

Year	Hard Ration/ 2 Months Part Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	35.64225	0.5888751021593	0.7832038858719	297.7444509434	25010.533879245	3126.3167349057	15.631583674528	12.50526693962
123	348.1908375	5.7527489146658	7.6511560565055	2908.6797195732	244329.09644415	30541.137055519	152.70568527759	122.1645482221
124	314.7550125	5.2003279854973	6.9164362207114	2629.3670679739	220866.83370981	27608.354213726	138.04177106863	110.4334168549
125	153.3465375	2.5335650228616	3.3696414804059	1281.010054416	107604.84457094	13450.605571368	67.253027856839	53.80242228547
126	153.3465375	2.5335650228616	3.3696414804059	1281.010054416	107604.84457094	13450.605571368	67.253027856839	53.80242228547
127	170.9979375	2.8251984067881	3.7575138810282	1428.4644491689	119991.01373019	14998.876716274	74.994383581368	59.99550686509
128	119.4015375	1.9727315922337	2.6237330176708	997.44391066037	83785.288495471	10473.161061934	52.36580530967	41.89264424774
129	47.2684125	0.7809605521494	1.0386775343587	394.86585517969	33168.731835094	4146.0914793868	20.730457396934	16.58436591755
130	47.2684125	0.7809605521494	1.0386775343587	394.86585517969	33168.731835094	4146.0914793868	20.730457396934	16.58436591755

§ A6.14 | Meat Animals: Full Support

Year	Green Ration/ 4 Months Full Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	101.880625	1.5149039510481	2.014822254894	765.9591031831	64340.56466738	8042.5705834225	40.212852917113	32.17028233369
123	995.2766770833	14.799168836072	19.682894551976	7482.6909532387	628546.04007205	78568.255009006	392.84127504503	314.273020036
124	899.7029479167	13.378044653422	17.792799389052	6764.1483659669	568188.46274122	71023.557842653	355.11778921326	284.0942313706
125	438.3292604167	6.517693903676	8.6685328918891	3295.4478558378	276817.61989037	34602.202486296	173.01101243148	138.4088099452
126	438.3292604167	6.517693903676	8.6685328918891	3295.4478558378	276817.61989037	34602.202486296	173.01101243148	138.4088099452
127	488.7844270833	7.2679320508617	9.6663496276461	3674.7799831284	308681.51858279	38585.189822849	192.92594911424	154.3407592914
128	341.30009375	5.0749282360111	6.7496545538948	2565.9629956634	215540.89163572	26942.611454465	134.71305727233	107.7704458179
129	135.1131145833	2.0090511922233	2.672038085657	1015.8076677928	85327.844094597	10665.980511825	53.329902559123	42.6639220473
130	135.1131145833	2.0090511922233	2.672038085657	1015.8076677928	85327.844094597	10665.980511825	53.329902559123	42.6639220473

Year	Hard Ration/ 4 Months Full Support	KM^2 Needed	Including Seed	Num Iugera	Person Hours	Person Days	PPL (build)	PPL (agric)
122	142.569	2.3555004086372	3.1328155434875	1190.9778037736	100042.13551698	12505.266939623	62.526334698113	50.02106775849
123	1392.76335	23.010995658663	30.604624226022	11634.718878293	977316.3857766	122164.54822208	610.82274111038	488.6581928883
124	1259.02005	20.801311941989	27.665744882846	10517.468271896	883467.33483924	110433.41685491	552.16708427453	441.7336674196
125	613.38615	10.134260091446	13.478565921624	5124.040217664	430419.37828377	53802.422285472	269.01211142736	215.2096891419
126	613.38615	10.134260091446	13.478565921624	5124.040217664	430419.37828377	53802.422285472	269.01211142736	215.2096891419
127	683.99175	11.300793627152	15.030055524113	5713.8577966756	479964.05492075	59995.506865094	299.97753432547	239.9820274604
128	477.60615	7.8909263689347	10.494932070683	3989.7756426415	335141.15398189	41892.644247736	209.46322123868	167.5705769909
129	189.07365	3.1238422085975	4.1547101374346	1579.4634207188	132674.92734038	16584.365917547	82.921829587736	66.33746367019
130	189.07365	3.1238422085975	4.1547101374346	1579.4634207188	132674.92734038	16584.365917547	82.921829587736	66.33746367019

§ A6.15 | Total Land and Labour for Pastured Support

Year	Group	Number	Land Farmed	Pasture Land	Total Land Used	Persons	% of Labour	Total Labour	Total Labour %
122	Personnel	1239	7.6020064764589			121.37978625965	9.7965929184547		
	Working Animals	413	13.291877656252	24.115443699025		212.22887324569	17.129045459701		
	Meat Animals	420	6.9382528117003	9.227142247293	61.174722890729	110.78175819865	8.9412234220055	444.390417704	35.86686180016
123	Personnel	12114	74.326639593077			1186.7592661416	9.7965929184547		
	Working Animals	4038	129.92314120333	235.76328753616		2074.4579945148	17.124467512917		
	Meat Animals	4103	67.780122110492	90.140392001531	597.93358244459	1082.2322711644	8.9337318075319	4343.4495318208	35.8547922389
124	Personnel	10952	67.197074197076			1072.9228564292	9.7965929184547		
	Working Animals	3651	117.47073650447	213.16749670339		1875.6328257324	17.125938876301		
	Meat Animals	3709	61.271380187135	81.484453798118	540.59114139019	978.30843133044	8.9326920318704	3926.864113492	35.85522382663
125	Personnel	5334	32.727282118992			522.55026627037	9.7965929184547		
	Working Animals	1778	57.216831286053	103.81580920244		913.57022300128	17.127300768678		
	Meat Animals	1807	29.851006739863	39.698681049663	263.30961039701	476.62532634514	8.9356079179816	1912.7458156168	35.85950160511
126	Personnel	5334	32.727282118992			522.55026627037	9.7965929184547		
	Working Animals	1778	57.216831286053	103.81580920244		913.57022300128	17.127300768678		
	Meat Animals	1807	29.851006739863	39.698681049663	263.30961039701	476.62532634514	8.9356079179816	1912.7458156168	35.85950160511
127	Personnel	5948	36.494539565761			582.70134678968	9.7965929184547		
	Working Animals	1983	63.809300464646	115.7830755242		1018.8309199369	17.128966374191		
	Meat Animals	2015	33.28709384661	44.268313400703	293.64232280192	531.48867326256	8.9355863023296	2133.0209399891	35.86114559498
128	Personnel	4154	25.487275950936			406.95046983261	9.7965929184547		
	Working Animals	1385	44.566923170531	80.867241811434		711.59155486662	17.130273347776		
	Meat Animals	1407	23.243146919196	30.910926528431	205.07551438053	371.11888996547	8.9340127579555	1489.6609146647	35.86087902419
129	Personnel	1644	10.086923847699			161.0559875794	9.7965929184547		
	Working Animals	548	17.645641033024	32.003165719111		281.74458199103	17.137748296291		
	Meat Animals	557	9.2014448002788	12.236948170815	81.174123570927	146.91771265868	8.9366005266839	589.71828222911	35.87094174143
130	Personnel	1644	10.086923847699			161.0559875794	9.7965929184547		
	Working Animals	548	17.645641033024	32.003165719111		281.74458199103	17.137748296291		
	Meat Animals	557	9.2014448002788	12.236948170815	81.174123570927	146.91771265868	8.9366005266839	589.71828222911	35.87094174143

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